

# MIPS 24-160 $\mu\text{m}$ photometry for the Herschel-SPIRE Local Galaxies Guaranteed Time Programs

G. J. Bendo<sup>1,2</sup>, F. Galliano<sup>3</sup>, S. C. Madden<sup>3</sup>

<sup>1</sup> UK ALMA Regional Centre Node, Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, United Kingdom

<sup>2</sup> Astrophysics Group, Imperial College, Blackett Laboratory, Prince Consort Road, London SW7 2AZ, United Kingdom

<sup>3</sup> Laboratoire AIM, CEA, Université Paris Diderot, IRFU/Service d'Astrophysique, Bat. 709, 91191 Gif-sur-Yvette, France

## ABSTRACT

We provide an overview of ancillary 24, 70, and 160  $\mu\text{m}$  data from the Multiband Imaging Photometer for *Spitzer* (MIPS) that are intended to complement the 70-500  $\mu\text{m}$  *Herschel* Space Observatory photometry data for nearby galaxies obtained by the *Herschel*-SPIRE Local Galaxies Guaranteed Time Programs and the *Herschel* Virgo Cluster Survey. The MIPS data can be used to extend the photometry to wave bands that are not observed in these *Herschel* surveys and to check the photometry in cases where *Herschel* performs observations at the same wavelengths. Additionally, we measured globally-integrated 24-160  $\mu\text{m}$  flux densities for the galaxies in the sample that can be used for the construction of spectral energy distributions. Using MIPS photometry published by other references, we have confirmed that we are obtaining accurate photometry for these galaxies.

**Key words:** infrared: galaxies, galaxies: photometry, catalogues

## 1 INTRODUCTION

The *Herschel*-SPIRE Local Galaxies Guaranteed Time Programs (SAG2) comprise several *Herschel* Space Observatory (Pilbratt et al. 2010) programs that used primarily the Photodetector Array Camera and Spectrometer (PACS; Poglitsch et al. 2010) and Spectral and Photometric Imaging Receiver (SPIRE; Griffin et al. 2010) to perform far-infrared and submillimetre observations of galaxies in the nearby universe. Three of the programs include photometric surveys of galaxies. The Very Nearby Galaxies Survey (VNGS; PI: C. D. Wilson) has performed 70-500  $\mu\text{m}$  photometric and spectroscopic observations of 13 archetypal nearby galaxies that includes Arp 220, M51, and M81. The Dwarf Galaxy Survey (DGS; PI: S. C. Madden) is a 70-500  $\mu\text{m}$  photometric and spectroscopic survey of 48 dwarf galaxies selected to span a range of metallicities (with  $12+\log(\text{O}/\text{H})$  values ranging from 7.2 to 8.5). The *Herschel* Reference Survey (HRS; Boselli et al. 2010) is a 250-500  $\mu\text{m}$  photometric survey of a volume-limited sample of 323 nearby galaxies designed to include both field and Virgo Cluster galaxies. The HRS also significantly overlaps with the *Herschel* Virgo Cluster Survey (HeViCS Davies et al. 2010a), a 100-500  $\mu\text{m}$  survey that will image 60 square degrees of the Virgo Cluster, and both collaborations will be sharing their data.

The far-infrared and submillimetre photometric data from these surveys can be used to construct spectral energy distributions (SEDs) of the dust emission and to map the distribution of cold dust within these galaxies. However, the surveys benefit greatly from the inclusion of 24, 70, and 160  $\mu\text{m}$  data from the Multi-

band Imaging Photometer for *Spitzer* (MIPS; Rieke et al. 2004), the far-infrared photometric imager on board the *Spitzer* Space Telescope (Werner et al. 2004). The 24  $\mu\text{m}$  MIPS data are particularly important either when attempting to model the complete dust emission from individual galaxies, as it provides constraints on the hot dust emission, or when attempting to measure accurate star formation rates, as 24  $\mu\text{m}$  emission has been shown to be correlated with other star formation tracers (Calzetti et al. 2005, 2007; Prescott et al. 2007; Kennicutt et al. 2007, 2009; Zhu et al. 2008). The 70  $\mu\text{m}$  MIPS data are less critical for the VNGS and DGS galaxies, which have been mapped with PACS at 70  $\mu\text{m}$ , but the data are more important for the HRS galaxies, most of which will not be mapped with PACS at 70  $\mu\text{m}$ . None the less, the MIPS 70  $\mu\text{m}$  data can be used to check the PACS photometry, and the data may be useful as a substitute for PACS photometry in situations where the MIPS data are able to detect emission at higher signal-to-noise levels but where the higher resolution of PACS is not needed. For galaxies without 70  $\mu\text{m}$  PACS observations, the MIPS data will provide an important additional data point that is useful for constraining the part of the far-infrared SED that represents the transition between the  $\sim 20$  K dust emission from the diffuse interstellar medium and the hot dust emission from large grains in star forming regions and very small grains. The 160  $\mu\text{m}$  MIPS data are less important, as 160  $\mu\text{m}$  PACS observations with equivalent sensitivities and smaller PSFs have been performed on the VNGS and DGS samples as well as the fraction of the HRS sample that falls within the HeViCS fields. For these galaxies, the MIPS 160  $\mu\text{m}$  data can primarily be used to check PACS 160  $\mu\text{m}$  photometry. An addi-

tional follow-up program (Completing the PACS coverage of the Herschel Reference Survey, P.I.: L. Cortese) has been submitted to perform PACS 160  $\mu\text{m}$  observations on the HRS galaxies outside the HeViCS field. However, those observations have not yet been performed at the time of this writing, so the MIPS 160  $\mu\text{m}$  data can serve as a substitute for the missing PACS data.

The pipeline processing from the MIPS archive is not optimized for observations of individual galaxies. The final 24  $\mu\text{m}$  images may include gradients from zodiacal light emission, incomplete flatfielding, and foreground asteroids, while the 70 and 160  $\mu\text{m}$  images may include short-term variations in the background signal (“drift”). Moreover, many galaxies are often observed multiple times in multiple Astronomical Observation Requests (AORs), and optimal images can often be produced by combining the data from these multiple AORs, which is something that the MIPS pipeline is not designed to do. Hence, to get the best MIPS images for analysis, it is necessary to reprocess the archival data.

Work on reprocessing the archival MIPS data for the SAG2 and HeViCS programs has been ongoing since before the launch of *Herschel*. Either these reprocessed MIPS data or earlier versions of the data have already been used in multiple papers from the SAG2 collaboration (Cortese et al. 2010a; Eales et al. 2010; Galametz et al. 2010; Gomez et al. 2010; O’Halloran et al. 2010; Pohlen et al. 2010; Sauvage et al. 2010; Auld et al. 2011; Bendo et al. 2012; Smith et al. 2011; Foyle et al. 2012) and the HeViCS collaboration (de Looze et al. 2010; Smith et al. 2010; Davies et al. 2012), and the data have also been used in other publications outside of these collaboration (Young et al. 2009; Wilson et al. 2009; Whaley et al. 2009; Galametz et al. 2010; Cortese et al. 2010b; Bendo et al. 2010; de Looze et al. 2011). The data processing has been described with some details in some of these papers but not in others. Global photometry measurements (printed numerical values, not just data points shown in figures) have only been published for 11 galaxies, and some of the measurements are based either on older versions of the data processing or on images created before all of the MIPS data for the targets were available.

The goal of this paper is to describe the MIPS data processing for SAG2 in detail and to present photometry for all of the SAG2 galaxies as well as the 500  $\mu\text{m}$  flux-limited sample of HeViCS galaxies published by Davies et al. (2012). While the MIPS data is incomplete for the DGS, HRS, and HeViCS samples and hence cannot be used to create statistically complete datasets, the data are still useful for constructing SEDs for individual galaxies and subsets of galaxies in the SAG2 and HeViCS samples. The paper is divided into two primary sections. Section 2 describes the data processing in detail. Section 3 describes the globally-integrated photometry for these galaxies, which can be used as a reference for other papers, and also discusses how the photometry compares to the MIPS photometry from other surveys.

## 2 DATA PROCESSING

### 2.1 Overview of MIPS

This section gives a brief overview of the MIPS instrument and the type of data produced by the instrument. Additional information on the instrument and the ar-

rays can be found in the MIPS Instrument Handbook (MIPS Instrument and MIPS Instrument Support Teams 2011)<sup>18</sup>.

MIPS has four basic observing modes, but most observations were performed in one of the two imaging modes. The photometry map mode produced maps of multiple dithered frames that were usually  $\sim 5$  arcmin in size. The observing mode could also be used to produce raster maps or could be used in cluster mode to produce maps of multiple objects that are close to each other. Although intended to be used for observing sources smaller than 5 arcmin, the mode was sometimes used to image larger objects. Because the 24, 70, and 160  $\mu\text{m}$  arrays are offset from each other in the imaging plane, observations in each wave band need to be performed in separate pointings. The scan map observing mode was designed to be used primarily for observing objects larger than 5 arcmin. The telescope scans in a zig-zag pattern where each of the arrays in the instrument pass over the target region in each scan leg. In typical observations, the telescope scans a region that is 1 degree in length, although longer scan maps were also produced with the instrument. In both observing modes, a series of individual data frames are taken in a cycle with the telescope pointing at different offsets from the target. These cycles include stimflash observations, which are frames in which the arrays are illuminated with an internal calibration source. Between 6 and 32 frames may be taken during a photometry map observation. In scan map observations, the number of frames per cycle may vary, but the data are always bracketed by stimflash frames. In typical 1 degree long scan map legs taken with the medium scan rate, each scan leg contains 4 cycles of data, and each cycle contains 25 frames.

The other two observing modes were a 65–97  $\mu\text{m}$  low resolution spectroscopy mode using the 70  $\mu\text{m}$  array and a total power mode that could be used to measure the total emission from the sky. However, since our interest is in working with photometric images of individual galaxies, we did not use the data from either of these observing modes.

Details on the three arrays are given in Table 1. The 70  $\mu\text{m}$  array is actually a  $32 \times 32$  array, but half of the array was effectively unusable, so the array effectively functions as a  $32 \times 16$  array. Details on the effective viewing area are given in the table. Also, the 70  $\mu\text{m}$  array can be used in wide field-of-view and super-resolution modes for producing photometry maps, but virtually no super-resolution data was taken for our target galaxies, so we only list data for the wide field-of-view mode.

### 2.2 Overview of data

#### 2.2.1 Archival data

*Spitzer* observations of multiple galaxies within the SAG2 samples were performed in other survey programs before SAG2 began working on the MIPS analysis and data reduction. The only *Spitzer* observing program devoted to SAG2 photometry that was awarded observing time was a program that included MIPS 24  $\mu\text{m}$  observations for 10 of the DGS galaxies, which is described in the next subsection. All other MIPS data originate from an assortment of programs. Some galaxies were observed as specific targets in surveys of nearby galaxies. Others were observed in surveys of wide fields, such as the wide field surveys of the Virgo Cluster. Still others were serendipitously observed in observations with other targets, such as

<sup>18</sup> The MIPS Instrument Handbooks is available at [http://irsa.ipac.caltech.edu/data/SPITZER/docs/mips/mipsinstrumenthandbook/MIPS\\_Instrument\\_Handbook.pdf](http://irsa.ipac.caltech.edu/data/SPITZER/docs/mips/mipsinstrumenthandbook/MIPS_Instrument_Handbook.pdf).

**Table 1.** Data on the three MIPS arrays<sup>a</sup>

Wave Band ( $\mu\text{m}$ )	Pixel Size (arcsec)	Array Size (pixels) (arcmin)		PSF FWHM <sup>b</sup> (arcsec)	Flux Conversion Factors (MJy/sr) [MIPS unit] <sup>-1</sup>	Calibration Uncertainty
24	$2.5 \times 2.6$	$128 \times 128$	$5.4 \times 5.4$	$6^c$	$4.54 \times 10^{-2}^c$	$4\%^c$
70	$9.9 \times 10.1$	$32 \times 16$	$5.2 \times 2.6$	$18^d$	$702^d$	$10\%^d$
160	$16 \times 18$	$2 \times 20$	$2.1 \times 5.3$	$38^e$	$41.7^e$	$12\%^e$

<sup>a</sup> Except where noted, these data come from the MIPS Instrument Handbook (MIPS Instrument and MIPS Instrument Support Teams 2011).

<sup>b</sup> This is the full-width and half-maximum (FWHM) of the point spread function (PSF).

<sup>c</sup> Data are from Engelbracht et al. (2007).

<sup>d</sup> Data are from Gordon et al. (2007).

<sup>e</sup> Data are from Stansberry et al. (2007).

scan map observations of zodiacal light. Both photometry maps and scan map data are available for these galaxies. Consequently, the observed areas vary significantly among the galaxies. The coverage (the number of data frames covering each pixel in the final mosaics) and on-source integration times also vary among the galaxies.

Given the inhomogeneity of the data as well as the incomplete coverage of the galaxies in the sample, we opted to use all data available for every galaxy to produce the best images for each galaxy. This means that the data set will not be uniform and that the noise levels in the data will vary among the galaxies in the sample, but the resulting images will be the best on hand for analysis. While we generally attempted to use all available, we made some judgments on selecting data for final images. When both scan map and photometry map data were available for individual galaxies, we used only the scan map data to create final images if the optical discs of the galaxies were larger than the areas covered in the photometry maps or if the background area in the photometry map was too small to allow us to apply data processing steps that rely on measurements from the background in on-target frames. We also did not use observations that covered less than half of the optical discs of individual objects. When multiple objects were covered in regions covered in multiple overlapping or adjacent AORs, we made larger mosaics using all of the data whenever technically feasible. Also, for photometry map data, we often used the serendipitous data taken when individual arrays were in off-target positions if those fields covered galaxies in our samples, and when multiple fields were observed using the cluster option in the photometry map data (see the MIPS Instrument handbook by the MIPS Instrument and MIPS Instrument Support Teams 2011), we combined the data from all pointings that covered SAG2 or HeViCS galaxies.

### 2.2.2 SAG2 observations of dwarf galaxies

Ten of the dwarf galaxies were observed by DGS with MIPS in cycle 5 as part of the program Dust Evolution in Low-Metallicity Environments: Bridging the Gap Between Local Universe and Primordial Galaxies (PI: F. Galliano; ID: 50550). Since these were objects smaller than 5 arcmin in diameter and since SAG2 intended to rely upon *Herschel* for 70 and 160  $\mu\text{m}$  photometry, these galaxies were mapped only at 24  $\mu\text{m}$  using the photometry map mode. One AOR was performed per object. Each observation uses a dither pattern to cover a  $\sim 6$  arcmin square region around the targets, and the integration times were set to 3 s per frame, giving a total time of 328 s per AOR.

### 2.3 Data processing for individual data frames

The raw data from the *Spitzer* archive were reprocessed using the MIPS Data Analysis Tools (Gordon et al. 2005) along with additional processing steps, some of which are performed by software from the MIPS Instrument Team and some of which were developed independently. The scan map data processing is a variant of the data processing pipeline used in the fourth data delivery of MIPS data from the *Spitzer* Infrared Nearby Galaxies Survey (SINGS; Kennicutt et al. 2003), although changes have been made to the background subtraction, and an asteroid removal step has been added to the 24  $\mu\text{m}$  data processing. Although other data processing software for MIPS is available from the *Spitzer* Science Center, we have continued to use the MIPS DAT because of our familiarity with the software and because we have developed an extensive range of tools to work with the intermediate and final data products produced by the MIPS DAT.

Separate sections are used to describe the processing steps applied to the 24  $\mu\text{m}$  data frames and the steps applied to the 70 and 160  $\mu\text{m}$  data frames, as the data from the 24  $\mu\text{m}$  silicon-based detectors differs somewhat from the data from the 70 and 160  $\mu\text{m}$  germanium-gallium detectors. The tools for processing photometry map data frames differ slightly from the tools for the scan map data frames. However, the differences are small enough that it is possible to describe the data processing for both observing modes in the same sections. The mosaicking and post-processing steps applied to all data are very similar, and so these steps are described in the last subsection.

#### 2.3.1 MIPS 24 $\mu\text{m}$ data frame processing

The raw 24  $\mu\text{m}$  data consist of slopes to the ramps measured by the detectors (the counts accumulated in each pixel during non-destructive readouts). The following data processing steps were applied to MIPS 24  $\mu\text{m}$  data frames:

1. The MIPS DAT program `mips_sloper` was applied to the frames. This applies a droop correction, which removes an excess signal in each detector that is proportional to the signal in the entire array, a dark current subtraction, and an electronic nonlinearity correction.
2. The MIPS DAT program `mips_caler` was applied to the data frames. This corrects the detector responsivity using a mirror-position dependent flatfield that removes spots from the images caused by material on the scan mirror. This data processing step also included a correction for variations in the readout offsets between different columns in the data frames.

3. To remove latent images from bright sources, pixels with signals above 2500 MIPS units in individual frames were masked out in the following three frames. In a few cases, this threshold was lowered to remove additional latent image effects.
4. When some 24  $\mu\text{m}$  data frames were made, the array was hit by strong cosmic rays that also caused severe “jailbar” effects or background offsets in the data. When we have identified data frames with these problems or other severe artefacts, we masked out those data frames manually at this stage in the data processing.
5. A mirror-position independent flatfield was created from on-target frames falling outside “exclusion” regions that included the optical disc of target galaxies and bright foreground or background sources. These flatfields correct for responsivity variations in the array that are specific to each observation. This flatfield was then applied to the data frames. In the case of some photometry map data, not enough background area was available for properly making flatfields. In these cases, data from the off-target pointings were used to build the mirror-position independent flatfields that were then applied to the data.
6. Gradients in the background signal, primarily from zodiacal light, were then subtracted from the data frames. This step differs between the photometry and scan map modes. For photometry map data, the background signal outside the exclusion regions in each frame was fit with a plane, and then this plane was subtracted from the data (although this step was skipped if not enough area was available in the data frames to measure the background). In the scan map data, two different approaches were used. Before applying either of these methods, we typically discarded the first five frames of data from each scan leg because the background signal was often ramping up to a stable background level; these frames usually did not cover any targets. In the standard approach, the background was subtracted in two steps. First, the median signal for data outside the exclusion regions in each data frame were fit with a second-order polynomial that was a function of time, and then this function was subtracted from the data. Second, we measured the mean residual background signal as a function of the frame position within a stimflash cycle and subtracted these background variations from the data. The alternate background subtraction approach relies upon using data from multiple scan legs; it was generally applied when the standard approach did not properly subtract the background. It was also sometimes used in place of the standard approach on data that did not scan 1 degree with the medium scan rate ( $6.5 \text{ arcsec s}^{-1}$ ), as the code was simply more flexible to use. For all forward scan leg data or all reverse scan leg data, we measured the median background level as a position of location within the scan leg. This gives the background signal as a function of position in a scan leg and scan direction that is then applied to each scan leg. Note that these steps will also remove large scale structure outside of the exclusion regions from the data but do not significantly affect signal from compact and unresolved sources.
7. In cases where we had data from multiple AORs that overlapped similar regions, we compared the data from pairs of AORs to perform asteroids removal in a three step process that involved. In the first step, we used the `mips_enhancer` in the MIPS DAT to make preliminary mosaics of the data from each AOR. In the second step, we subtracted the data from each AOR to produce difference maps in which asteroids and other transient sources will appear as either bright or dark sources but where stationary objects will appear as noise. To identify locations that contained

signal from asteroids, we looked for data where signal in either of the AORs was above a set S/N threshold, where the signal in the difference maps was above a set S/N threshold, and where the coverage was above a set threshold; these thresholds needed to be manually adjusted for each comparison. When performing this step, we visually confirmed that the software was identifying transient sources and not stationary sources or background noise. In the final step, we went through the data frames from each AOR and masked out data within 5 pixels ( $\sim 12.5 \text{ arcsec}$ ) of pixels identified as containing signal from asteroids. In cases with bright asteroids, we may identify multiple pixels containing signal from asteroids, and so we often masked out regions significantly larger than 11 pixels.

### 2.3.2 MIPS 70-160 $\mu\text{m}$ data frame processing

The raw 70 and 160  $\mu\text{m}$  data consist of the counts accumulated in each pixel during non-destructive readouts, which are referred to as ramps. We applied the following processing steps to the 70 and 160  $\mu\text{m}$  data frames:

1. The MIPS DAT program `mips_sloper` was applied to the individual data frames to convert the ramps into slopes. This step also removes cosmic rays and readout jumps, and it includes a non-linearity corrections.
2. The MIPS DAT program `mips_caler` was applied to adjust the detector responsivity relative to the stim flashes observed during the observations and to apply illumination corrections. This step also includes electronic nonlinearity and dark current corrections.
3. Short term drift in the signal was removed from the data on a pixel-by-pixel basis. The background signal was measured in data falling outside the optical disc of the galaxy and other sources that we identified in exclusion regions similar to those described in the 24  $\mu\text{m}$  data processing. In the 70  $\mu\text{m}$  photometry map data, the background was measured as a function of time and then subtracted from the data. The 160  $\mu\text{m}$  photometry map observations often did not include enough background data to perform this step properly, and the background variations in the 160  $\mu\text{m}$  data was not problematic. However, when the 160  $\mu\text{m}$  photometry map data were to be combined with scan map data, we did measure median background signals in the areas outside the exclusion regions on a frame-by-frame basis and subtract these backgrounds from the data. In the case of the scan map data, the median background signal was measured for each pixel during each stim flash cycle, a spline procedure was used to describe the background signal as a function of time during the entire AOR, and then this background was subtracted from the data. This procedure also removes gradients and large-scale structure from regions outside the exclusion regions but will generally not affect compact and unresolved sources.
4. In scan map data, residual variations in the background signal as a function of time since the last stim flash were measured in data outside the exclusion regions and then subtracted from the data.
5. Any problematic data that we have identified, such as individual 160  $\mu\text{m}$  detector pixels with very poor drift correction over a subset of the data frames or cosmic ray hits on 160  $\mu\text{m}$  detectors that were not filtered out in the previous data processing steps, were masked out manually.

## 2.4 Mosaicking data and post-processing

Final images for the galaxies were created using all suitable AORs using the `mips_enhancer` in a two step process. In the first step, the `mips_enhancer` is used to identify pixels from individual frames that are statistical outliers compared to co-spatial pixels from other frames. These pixels are then masked out in enhanced versions of the data frames. In the second step, the `mips_enhancer` is used to create the final maps. In these images, north is up, east is left, and the pixel scales are set to 1.5, 4.5, and 9.0 arcsec pixel<sup>-1</sup>. The pixel scales are based on a convention originally adopted by SINGS, as it allows for fine sampling of PSF substructure and as the pixel scales are integer multiples of each other, which allows for easier comparisons among the images.

The CRPIX keywords in the final FITS images correspond to the centres of the optical discs of the individual target galaxies as given by the NASA/IPAC Extragalactic Database. In cases where two or more galaxies fell in contiguous areas, we sometimes produced separate final mosaics for each galaxy in which the final maps were constructed using different CRPIX values. We also attempted to do this for a large amount of contiguous data for the Virgo Cluster covering a  $\sim 5^\circ$  region centered on a point near NGC 4486 and an overlapping  $\sim 2.5^\circ$  region approximately centered on RA=12:28:10 Dec=+80:31:35. While we succeeded at doing this with the 70 and 160  $\mu\text{m}$  data, `mips_enhancer` failed to execute properly when we attempted this with the 24  $\mu\text{m}$  data, probably because of the relatively large angular area compared to the pixel size. We therefore produced final 24  $\mu\text{m}$  mosaics of each galaxy in this region based on subsets of the contiguous data. In doing this, we ensured that, when producing a 24  $\mu\text{m}$  image of an individual galaxy, we mosaicked all AORs that covered each galaxy that was being mapped. NGC 4380 is an exception, as it lies near the ends of a  $\sim 5^\circ$  scan to the north and a  $\sim 2.5^\circ$  scan to the south. We therefore measured the 24  $\mu\text{m}$  flux density for this galaxy in the map produced for NGC 4390, which is nearby and which falls in almost all of the scan maps centered on or to the north of NGC 4380. We also had problems with producing 24  $\mu\text{m}$  maps of NGC 4522 with the CRPIX values set to the central coordinates of the galaxy, so we measured the flux density in the map centered on NGC 4519. In the cases of NGC 3226/NGC 3227 and NGC 4567/NGC 4568, where the galaxies appear close enough that their optical discs overlap, we only made one map with the central position set to the centre of the galaxy that is brighter at optical wavelengths.

We performed a few post-processing steps to the final mosaics. We applied the flux calibration factors given in Table 1 to produce maps in units of MJy sr<sup>-1</sup>. Next, we applied a non-linearity correction to 70  $\mu\text{m}$  pixels that exceeded 66 MJy sr<sup>-1</sup>. This correction, given by Dale et al. (2007) as

$$f_{70\mu\text{m}}(\text{true}) = 0.581(f_{70\mu\text{m}}(\text{measured}))^{1.13} \quad (1)$$

is based on data from Gordon et al. (2007). When applying this correction, we adjusted the calculations to include the median background signal measured in the individual data frames before the drift removal steps. We then measured and subtracted residual background surface brightnesses outside the optical discs of the galaxies in regions that did not contain any nearby, resolved galaxies (regardless of whether they were detected in the MIPS bands) or point-like sources. In the case of the 24  $\mu\text{m}$  data, we used multiple small circular regions around the centres of targets. For the 70 and 160  $\mu\text{m}$  images, we used whenever possible two or more regions that were as large as or larger than the optical discs of the target

galaxies and that straddled the optical disc of the galaxy. In some of the smaller photometry maps, however, we could not often do this, so we made our best effort to measure the background levels within whatever background regions were observed. In cases where multiple galaxies fall within the final mosaics, we only performed this background subtraction for the central galaxy, although when performing photometry on the other galaxies in these fields, we measured the backgrounds in the same way around the individual targets.

The final images have a few features and artefacts that need to be taken into consideration when using the data. First of all, the large scale structure outside of the target galaxies in the images has been mostly removed. Although the images, particularly the 160  $\mu\text{m}$  images, may contain some cirrus structure, most of the large scale features in the cirrus have been removed. Second, all scan map data may contain some residual striping. Additionally, the 70  $\mu\text{m}$  images for bright sources are frequently affected by latent image effects that manifest themselves as positive or negative streaks aligned with the scan direction. Finally, many objects falling within the Virgo Cluster as well as a few objects in other fields were observed in fields covered only with MIPS scan map data taken using the fast scan rate. The resulting 160  $\mu\text{m}$  data contain large gaps in the coverage, and the data appear more noisy than most other 160  $\mu\text{m}$  data because of the poor sampling.

## 3 PHOTOMETRY

### 3.1 Description of measurements

For most galaxies, we performed aperture photometry within elliptical apertures with major and minor axes that were the greater of either 1.5 times the axis sizes of the D<sub>25</sub> isophotes given by (de Vaucouleurs et al. 1991) or 3 arcmin. The same apertures were used in all three bands for consistency. The lower limit of 3 arcmin on the measurement aperture dimensions ensures that we can measure the total flux densities of 160  $\mu\text{m}$  sources without needing to apply aperture corrections. We performed tests with measuring some unresolved sources in the DGS with different aperture sizes and found that the fraction of the total flux not included within a 3 arcmin aperture for these sources is below the 12% calibration uncertainty of the 160  $\mu\text{m}$  band. In galaxies much larger than 3 arcmin, we found that apertures that were 1.5 times the D<sub>25</sub> isophote contained all of the measurable signal from the target galaxies. The measured flux densities in apertures larger than this did not change significantly, but the measured flux densities decreased if we used smaller apertures.

For the elliptical galaxies NGC 3640, NGC 4125, NGC 4365, NGC 4374, NGC 4406, NGC 4472, NGC 4486, NGC 4552, NGC 4649, NGC 4660, and NGC 5128, however, we used measurement apertures that were the same size as the D<sub>25</sub> isophotes. Additionally, for the nearby dwarf elliptical galaxy NGC 205, we used a measurement aperture that was 0.5 times the size of the D<sub>25</sub> isophote. These were all cases where the 70 and 160  $\mu\text{m}$  emission across most of the optical disc is within  $5\sigma$  of the background noise, and in many cases, the emission from the galaxies is not detected. Using smaller apertures in these specific cases allows us to avoid including background sources and artefacts from the data processing, thus allowing us to place better constraints on the flux densities. We also treated NGC 4636 as a special case in which, at 160  $\mu\text{m}$ , we only measured the flux density for the central source because of issues with possible background sources falling within the optical disc of the galaxy (although the background sources are not as

**Table 2.** Special measurement apertures

Galaxy	R.A. (J2000)	Dec. (J2000)	Axis sizes (arcmin)	Position Angle <sup>a</sup>
Mrk 1089	05:01:37.8	-04:15:28	$3.0 \times 3.0$	$0^\circ$
NGC 891	02:22:33.4	+42:20:57	$20.3 \times 10.0$	$22^\circ$
NGC 3395/3396	10:49:50.1	+32:58:58	$6.0 \times 6.0$	$0^\circ$
NGC 4038/4039	12:01:53.0	-18:52:10	$10.4 \times 10.4$	$0^\circ$
NGC 4567/4568	12:36:34.3	+11:14:20	$8.5 \times 8.5$	$0^\circ$
NGC 5194/5195	13:29:52.7	+47:11:43	$19.6 \times 19.6$	$0^\circ$
NGC 6822	19:44:56.6	-14:47:21	$30.0 \times 30.0$	$0^\circ$
UM 311	01:15:30.4	-00:51:39	$4.7 \times 3.5$	$72^\circ$

<sup>a</sup> Position angle is defined as degrees from north through east.

problematic at  $24\ \mu\text{m}$ , and so the  $24\ \mu\text{m}$  measurement is still for the entire optical disc). Additional details on NGC 4636 are given in Section 3.1.1.

A few galaxies in the various samples are so close to each other or so close to other galaxies at equivalent distances that attempting to separate the infrared emission from the different sources would be very difficult. Objects where this is the case are Mrk 1089 (within NGC 1741), NGC 3395/3396, NGC 4038/4039, NGC 4567/4568, NGC 5194/5195, and UM 311 (within NGC 450). In these cases, we used measurement apertures that were large enough to encompass the emission from the target galaxy and all other nearby sources. Details on the other apertures are given in Table 2.

Many of the galaxies in the DGS do not have optical discs defined by de Vaucouleurs et al. (1991), and some do not have optical discs defined anywhere in the literature. These are generally galaxies smaller than the minimum 3 arcmin diameter aperture that we normally use, so we used measurement apertures of that size in many cases. However, for sources fainter than 100 mJy in the  $24\ \mu\text{m}$  data, we found that background noise could become an issue when measuring  $24\ \mu\text{m}$  flux densities over such large apertures; although the galaxy would clearly be detected at a level much higher than  $5\sigma$  in the centre of the aperture, the integral of the aperture would make the detection appear weaker. Hence, for  $24\ \mu\text{m}$  DGS sources that were fainter than 10 mJy and did not appear extended in the  $24\ \mu\text{m}$  data, we used apertures with 1 arcmin diameters and divided the data by 0.93, which is an aperture correction that we derived empirically from bright point-like sources in the DGS.

NGC 891 and NGC 6822 were treated as special cases for selecting the measurement apertures. Details are given in the photometry notes below, and the parameters describing the measurement apertures are given in Table 2.

Before performing the photometry on individual galaxies, we identified and masked out emission that appeared to be unrelated to the target galaxies. We visually identified and masked out artefacts from the data processing in the final mosaics, such as bright or dark pixels near the edges of mapped field and streaking in the  $70\ \mu\text{m}$  images related to latent image effects. We also statistically checked for pixels that were  $5\sigma$  below the background, which are almost certainly associated with artefacts except when this becomes statistically probable in apertures containing large numbers of pixels. In cases where we determined that the  $< -5\sigma$  pixels were data processing artefacts or excessively noisy pixels, we masked them out. When other galaxies appeared close to individual galaxies in which we were measuring flux densities but when the optical discs did not overlap significantly, we masked out the adjacent galaxies. We also masked out emission from unresolved sources, particu-

larly unresolved  $24\ \mu\text{m}$  sources, that did not appear to be associated with the target galaxies and that appeared significantly brighter than the emission in the regions where we measured the background. Most of these sources appeared between the  $D_{25}$  isophote and the measurement aperture. In cases where the galaxies contained very compact  $24\ \mu\text{m}$  emission (as is the case for many elliptical and S0 galaxies), we also masked out unresolved sources within but near the  $D_{25}$  isophote. A few unresolved sources within the  $D_{25}$  isophote appeared as bright, unresolved sources in Digitized Sky Survey or 2MASS data, indicating that they were foreground stars, and we masked them out as well. In many  $24\ \mu\text{m}$  images, the measured flux densities changed by less than 4% (the calibration uncertainty) when the unresolved sources were removed.

As stated above, in cases where the MIPS  $160\ \mu\text{m}$  data for individual galaxies consists of only scan map data taken at the fast scan rate, our final  $160\ \mu\text{m}$  maps include gaps in the coverage. To make  $160\ \mu\text{m}$  measurements, we have interpolated the signal across these gaps using nearest neighbor sampling techniques. We also applied this interpolation technique to  $160\ \mu\text{m}$  data for the regions in the optical discs (but not in the whole measurement aperture, which may fall outside the scan region) of IC 1048, NGC 4192, NGC 4535, and NGC 5692. In many other cases, the observed regions did not completely cover the optical discs of the target galaxies. We normally measured the flux densities for the regions covered in the observed regions. Cases where the observed regions did not cover  $\gtrsim 90\%$  of the optical discs are noted in the photometry tables. Although we believe that these data are reliable (especially since the observations appear to cover most of the emission that is seen in the other bands), people using these data should still be aware of the limitations of these data.

As a quality check on the photometry, we examined the  $24/70$ ,  $24/160$ , and  $70/160\ \mu\text{m}$  flux density ratios to identify any galaxies that may have discrepant colours (for example, abnormally high  $24/70$  and low  $70/160\ \mu\text{m}$  colours, which would be indicative of problems with unmasked negative pixels in the final images). In such discrepant cases, we examined the images for unmasked artefacts, masked out the artefacts when identified, and repeated the photometry.

The globally-integrated flux densities for the galaxies in the four different samples are listed in Tables 3-6. No colour corrections have been applied to these data. We include three sources of uncertainty. The first source is the calibration uncertainty. The second source is the uncertainty based on the error map. Each pixel in the error map is based on the standard deviation of the overlapping pixels from the individual data frames; the uncertainties will include both instrumental background noise and shot noise from the astronomical sources. To calculate the total uncertainty traced by the data in the error map, we used the square root of the sum of the square of the error map pixels in the measurement region. The third source of uncertainty is from background noise (which includes both instrumental and astronomical sources of noise) measured in the background regions. The total uncertainties are calculated by adding these three sources of uncertainty in quadrature. Sources that are less than  $5\sigma$  detections within the measurement apertures compared to the combination of the error map and background noise are reported as  $5\sigma$  upper limits. Sources in which the surface brightness within the measurement aperture is not detected at the  $5\sigma$  level for regions unaffected by foreground/background sources or artefacts are reported as upper limits; in these cases, the integrated flux densities within the apertures are used as upper limits. This second case occurs when the target aperture includes emission from diffuse, extended emission (as described for NGC 4552

**Table 3.** Photometry for the Very Nearby Galaxies Survey

Galaxy	R. A. (J2000) <sup>a</sup>	Optical Disc		Position Angle <sup>bc</sup>	Wavelength ( $\mu\text{m}$ )	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>d</sup>			
		Declination (J2000) <sup>a</sup>	Axes (arcmin) <sup>b</sup>				Calibration	Error Map	Background	Total
NGC 205	00:40:22.0	+41:41:07	21.9 $\times$ 11.0	170°	24	0.1089	0.0044	0.0005	0.0008	0.0044
					70	1.302	0.130	0.019	0.023	0.134
					160	8.98	1.08	0.03	0.05	1.08
NGC 891 <sup>e</sup>	02:22:33.4	+42:20:57	13.5 $\times$ 2.5	22°	24	6.4531	0.2581	0.0005	0.0007	0.2581
					70	97.122	9.712	0.045	0.018	9.712
					160	287.27	34.47	8.72	0.04	35.56
NGC 1068	02:42:40.7	-00:00:48	7.1 $\times$ 6.0	70°	24					
					70	189.407	18.941	0.491	0.058	18.947
					160	237.39	28.49	5.53	0.06	29.02
NGC 2403	07:36:51.4	+65:36:09	21.9 $\times$ 12.3	127°	24	6.0161	0.2406	0.0022	0.0019	0.2407
					70	81.710	8.171	0.057	0.052	8.171
					160	221.04	26.53	0.24	0.11	26.53
NGC 3031	09:55:33.1	+69:03:55	26.9 $\times$ 14.1	157°	24	5.2748	0.2110	0.0017	0.0024	0.2110
					70	81.049	8.105	0.063	0.080	8.106
					160	316.30	37.96	0.97	0.40	37.97
NGC 4038 <sup>f</sup>					24	5.8226	0.2329	0.0073	0.0012	0.2330
					70	45.949	4.595	0.148	0.035	4.597
					160	80.28	9.63	3.62	0.06	10.29
NGC 4125	12:08:06.0	+65:10:27	5.8 $\times$ 3.2	95°	24	0.0790	0.0032	0.0002	0.0003	0.0032
					70	1.014	0.101	0.008	0.008	0.102
					160	1.37	0.16	0.01	0.01	0.17
NGC 4151	12:10:32.5	+39:24:21	6.3 $\times$ 4.5	50°	24	4.5925	0.1837	0.0104	0.0005	0.1840
					70	5.415	0.541	0.027	0.013	0.542
					160	9.38	1.13	0.02	0.02	1.13
NGC 5128	13:25:27.6	-43:01:09	25.7 $\times$ 20.0	35°	24	24.0374	0.9615	0.0135	0.0028	0.9616
					70	263.165	26.316	0.226	0.068	26.318
					160	582.51	69.90	22.50	0.14	73.43
NGC 5194 <sup>f</sup>					24	14.2309	0.5692	0.0037	0.0015	0.5693
					70	151.000	15.100	0.123	0.045	15.101
					160	458.44	55.01	7.80	0.11	55.56
NGC 5236	13:37:00.9	-29:51:57	12.9		24	40.4266	1.6171	0.0263	0.0017	1.6173
					70	312.808	31.281	0.290	0.051	31.282
					160	798.23	95.78	9.95	0.13	96.30
Arp 220	15:34:57.1	+23:30:11	1.5		24					
					70	74.976	7.498	0.309	0.023	7.504
					160	54.88	6.59	1.38	0.02	6.73

<sup>a</sup> Data are from NED.<sup>b</sup> Data are from de Vaucouleurs et al. (1991) unless otherwise specified. If de Vaucouleurs et al. (1991) specify both the minor/major axis ratio and the position angle, then both axes and the position angle are listed. If de Vaucouleurs et al. (1991) did not specify either of these data, then we performed photometry on circular regions, and so only the major axis is specified.<sup>c</sup> The position angle is defined as degrees from north through east.<sup>d</sup> Details on the sources of these uncertainties are given in Section 3.1.<sup>e</sup> A special measurement aperture was used for NGC 891. See Table 2.<sup>f</sup> These objects consist of two galaxies with optical discs that overlap. See Table 2 for the dimensions of the measurement apertures for these objects.

below) or large scale artefacts that are impossible to mask out for the photometry.

### 3.1.1 Notes on photometry

Aside from typical issues described above with the data processing and photometry, we encountered multiple problems that were unique to individual targets. Notes on these issues (in the order in which the galaxies appear in the table) are listed below.

#### Notes on the VNGS data

*Arp 220* - The centre of the galaxy, which is unresolved in the MIPS bands, saturated the 24  $\mu\text{m}$  detector, and so no 24  $\mu\text{m}$

flux density is reported for the source. The 160  $\mu\text{m}$  error contains two anomalously high pixels (pixels with error map values at least an order of magnitude higher than the image map values) located off the peak of the emission. We ascertained that the corresponding image map pixels did not look anomalous compared to adjacent pixels, so the unusually high values in the error map were probably some type of artefact of the data reduction possibly related to a combination of high surface brightness issues and coverage issues. We therefore excluded these pixels when calculating the error map uncertainty.

*NGC 891* - This is an edge-on spiral galaxy in which the central plane is very bright, and so features that look similar to Airy rings (except that they are linear rather than ring-shaped) appear

**Table 4.** Photometry for the Dwarf Galaxies Survey

Galaxy	R. A. (J2000) <sup>a</sup>	Optical Disc		Position Angle <sup>b,c</sup>	Wavelength ( $\mu\text{m}$ )	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>d</sup>			Total
		Declination (J2000) <sup>a</sup>	Axes (arcmin) <sup>b</sup>				Calibration	Error Map	Background	
IC 10	00:20:17.3	+59:18:14	6.3		24 70 160	9.8188	0.3928	0.0136	0.0013	0.3930
HS 0017+1055	00:20:21.4	+11:12:21			24 70 160	0.0237	0.0009	0.0005	0.0009	0.0014
Haro 11	00:36:52.4	-33:33:19			24 70 160	2.3046 4.912 2.01	0.0922 0.491 0.24	0.0123 0.038 0.01	0.0005 0.007 0.02	0.0930 0.493 0.24
HS 0052+2536	00:54:56.3	+25:53:08			24 70 160	0.0207	0.0008	0.0004	0.0008	0.0012
UM 311 <sup>e</sup>					24 70 160	0.3289 3.075 6.62	0.0132 0.308 0.79	0.0008 0.008 0.02	0.0009 0.008 0.01	0.0132 0.308 0.79
NGC 625	01:35:04.6	-41:26:10	$5.8 \times 1.9$	$92^\circ$	24 70 160	0.8631 6.252 7.87	0.0345 0.625 0.94	0.0016 0.036 0.03	0.0003 0.012 0.02	0.0346 0.626 0.95
UGCA 20	01:43:14.7	+19:58:32	$3.1 \times 0.8$	$153^\circ$	24 70 160	< 0.0085				
UM 133	01:44:41.2	+40:53:26			24 70 160	0.0094	0.0004	0.0002	0.0003	0.0005
UM 382	01:58:09.3	-00:06:38			24 70 160	< 0.070				
NGC 1140	02:54:33.5	-10:01:40	$1.7 \times 0.9$	$10^\circ$	24 70 160	0.3764 3.507 3.67	0.0151 0.351 0.44	0.0009 0.020 0.01	0.0006 0.008 0.01	0.0151 0.351 0.44
SBS 0335-052	03:37:44.0	-05:02:40			24 70 160	0.0768 0.051 < 0.07	0.0031 0.005	0.0005 0.005	0.0005 0.006	0.0032 0.009
NGC 1569	04:30:49.0	-64:50:53	$3.6 \times 1.8$	$120^\circ$	24 70 160	7.7189 46.120 33.49	0.3088 4.612 4.02	0.0091 0.068 0.11	0.0010 0.029 0.02	0.3089 4.613 4.02
NGC 1705	04:54:13.5	-53:21:40	$1.9 \times 1.4$	$50^\circ$	24 70 160	0.0532 1.315 1.29	0.0021 0.132 0.16	0.0000 0.002 0.01	0.0001 0.004 0.01	0.0021 0.132 0.16
Mrk 1089 <sup>e</sup>					24 70 160	0.5252 1.123	0.0210 0.112	0.0008 0.004	0.0003 0.004	0.0210 0.112
II Zw 40	05:55:42.6	+03:23:32			24 70 160	1.6545 5.438	0.0662 0.544	0.0063 0.031	0.0006 0.011	0.0665 0.545
Tol 0618-402	06:20:02.5	-40:18:09			24 70 160	< 0.0015 < 0.037 < 0.42				
NGC 2366	07:28:54.6	+69:12:57	$8.1 \times 3.3$	$25^\circ$	24 70 160	0.6919 5.230 5.50	0.0277 0.523 0.66	0.0013 0.021 0.21	0.0007 0.019 0.03	0.0277 0.524 0.69
HS 0822+3542	08:25:55.5	+35:32:32			24 70 160	0.0032 0.043 < 0.04	0.0001 0.004	0.0001 0.004	0.0002 0.006	0.0003 0.008
He 2-10	08:36:15.1	-26:24:34			24 70 160	5.7368 17.969 13.41	0.2295 1.797 1.61	0.0262 0.102 0.05	0.0007 0.009 0.01	0.2310 1.800 1.61
UGC 04483	08:37:03.0	+69:46:31			24 70 160	0.0101 0.142 0.27	0.0004 0.014 0.03	0.0001 0.003 0.01	0.0003 0.006 0.00	0.0005 0.016 0.03



**Table 4.** Photometry for the Dwarf Galaxies Survey (continued)

Galaxy	R. A. (J2000) <sup>a</sup>	Optical Disc		Position Angle <sup>b,c</sup>	Wavelength ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>d</sup>			
		Declination (J2000) <sup>a</sup>	Axes (arcmin) <sup>b</sup>				Calibration	Error Map	Background	Total
I Zw 18	09:34:02.0	+55:14:28			24	0.0061	0.0002	0.0001	0.0002	0.0003
					70	0.042	0.004	0.002	0.004	0.006
					160	< 0.12				
Haro 2	10:32:31.9	+54:24:03			24	0.8621	0.0345	0.0015	0.0001	0.0345
					70	3.988	0.399	0.019	0.005	0.399
					160	3.09	0.37	0.01	0.01	0.37
Haro 3	10:45:22.4	+55:57:37			24	0.8514	0.0341	0.0027	0.0004	0.0342
					70	4.898	0.490	0.018	0.007	0.490
					160	3.93	0.47	0.01	0.01	0.47
Mrk 153	10:49:05.0	+52:20:08			24	0.0358	0.0014	0.0003	0.0005	0.0015
					70	0.260	0.026	0.004	0.007	0.027
					160					
VII Zw 403	11:27:59.8	+78:59:39			24	0.0329	0.0013	0.0002	0.0005	0.0014
					70	0.425	0.043	0.005	0.007	0.043
					160	0.31	0.04	0.00	0.01	0.04
Mrk 1450	11:38:35.6	+57:52:27			24	0.0570	0.0023	0.0003	0.0004	0.0023
					70	0.264	0.026	0.004	0.005	0.027
					160	0.15	0.02	0.00	0.01	0.02
UM 448	11:42:12.4	+00:20:03			24	0.6425	0.0257	0.0018	0.0007	0.0258
					70	3.703	0.370	0.021	0.015	0.371
					160	2.67	0.32	0.01	0.01	0.32
UM 461	11:51:33.3	-02:22:22			24	0.0344	0.0014	0.0002	0.0029	0.0032
					70	0.090	0.009	0.003	0.011	0.014
					160	0.10	0.01	0.00	0.01	0.01
SBS 1159+545	12:02:02.3	+54:15:50			24	0.0062	0.0002	0.0001	0.0002	0.0004
					70					
					160					
SBS 1211+540	12:14:02.4	+53:45:17			24	0.0033	0.0001	0.0001	0.0002	0.0003
					70					
					160					
NGC 4214	12:15:39.1	+36:19:37	8.5		24	2.1044	0.0842	0.0015	0.0012	0.0842
					70	24.049	2.405	0.043	0.032	2.406
					160	38.18	4.58	0.34	0.05	4.59
Tol 1214-277	12:17:17.0	-28:02:33			24	0.0068	0.0003	0.0001	0.0002	0.0003
					70	0.073	0.007	0.004	0.005	0.010
					160					
HS 1222+3741	12:24:36.7	+37:24:37			24					
					70	0.062	0.006	0.004	0.007	0.010
					160					
Mrk 209	12:26:16.0	+48:29:37			24	0.0587	0.0023	0.0003	0.0005	0.0024
					70	0.466	0.047	0.004	0.004	0.047
					160	0.18	0.02	0.00	0.01	0.02
NGC 4449	12:28:11.8	+44:05:40	$6.2 \times 4.4$	$45^\circ$	24	3.2863	0.1315	0.0010	0.0008	0.1315
					70	43.802	4.380	0.053	0.019	4.381
					160	78.09	9.37	0.70	0.03	9.40
SBS 1249+493	12:51:52.4	+49:03:28			24	0.0043	0.0002	0.0001	0.0002	0.0003
					70					
					160					
NGC 4861	12:59:02.3	+34:51:34	$4.0 \times 1.5$	$15^\circ$	24	0.3657	0.0146	0.0012	0.0008	0.0147
					70	1.971	0.197	0.012	0.010	0.198
					160	2.00	0.24	0.01	0.02	0.24
HS 1304+3529	13:06:24.1	+35:13:43			24	0.0122	0.0005	0.0004	0.0007	0.0009
					70					
					160					
Pox 186	13:25:48.6	-11:36:38			24	0.0108	0.0004	0.0005	0.0009	0.0011
					70					
					160					
NGC 5253	13:39:55.9	-31:38:24	$5.0 \times 1.9$	$45^\circ$	24					
					70	23.626	2.363	0.074	0.015	2.364
					160	17.35	2.08	0.05	0.03	2.08

**Table 4.** Photometry for the Dwarf Galaxies Survey (continued)

Galaxy	R. A. (J2000) <sup>a</sup>	Optical Disc		Wavelength ( $\mu\text{m}$ )	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>d</sup>			
		Declination (J2000) <sup>a</sup>	Axes (arcmin) <sup>b</sup>			Calibration	Error Map	Background	Total
SBS 1415+437	14:17:01.3	+43:30:05		24	0.0187	0.0007	0.0003	0.0005	0.0009
				70	0.177	0.018	0.004	0.006	0.019
				160	< 0.06				
HS 1424+3836	14:26:28.1	+38:22:59		24					
				70	< 0.024				
				160					
HS 1442+4250	14:44:12.8	+42:37:44		24	0.0066	0.0003	0.0001	0.0001	0.0003
				70	0.079	0.008	0.004	0.006	0.010
				160	< 0.10				
SBS 1533+574	15:34:13.8	+57:17:06		24					
				70	0.270	0.027	0.004	0.005	0.028
				160					
NGC 6822 <sup>f</sup>	19:44:56.6	-14:47:21	15.5	24	4.5230	0.1809	0.0027	0.0032	0.1810
				70	52.413	5.241	0.082	0.096	5.243
				160	109.44	13.13	0.61	0.20	13.15
Mrk 930	23:31:58.2	+28:56:50		24	0.1985	0.0079	0.0005	0.0006	0.0080
				70	1.159	0.116	0.007	0.006	0.116
				160	0.96	0.12	0.01	0.02	0.12
HS 2352+2733	23:54:56.7	+27:49:59		24	0.0026	0.0001	0.0001	0.0003	0.0003
				70					
				160					

<sup>a</sup> Data are from NED.<sup>b</sup> Data are from de Vaucouleurs et al. (1991) unless otherwise specified. If de Vaucouleurs et al. (1991) specify both the minor/major axis ratio and the position angle, then both axes and the position angle are listed. If de Vaucouleurs et al. (1991) did not specify either of these data, then we performed photometry on circular regions, and so only the major axis is specified. If no optical dimensions are specified, then we performed photometry on a 3 arcmin diameter circular region centered on the source<sup>c</sup> The position angle is defined as degrees from north through east.<sup>d</sup> Details on the sources of these uncertainties are given in Section 3.1.<sup>e</sup> Special measurement apertures were used for these targets because of the presence of nearby associated sources. See Table 2.<sup>f</sup> A special measurement aperture was used for NGC 6822. See Table 2.

above and below the plane of the galaxy in the 160  $\mu\text{m}$  image. The measurement aperture we used for all three bands has a major axis corresponding to 1.5 times the D<sub>25</sub> isophote but a much broader minor axis that encompasses the vertically-extended emission. Note that this is the only edge-on galaxy where we have encountered this problem.

*NGC 1068* - This is another galaxy that is unresolved in the MIPS bands and that saturates the 24  $\mu\text{m}$  detector. It is not practical to perform 24  $\mu\text{m}$  photometry measurements on this galaxy. The 160  $\mu\text{m}$  error contains a few anomalously high pixels (pixels with error map values at least an order of magnitude higher than the image map values). This seemed similar to the phenomenon described for the anomalous 160  $\mu\text{m}$  error map pixels for Arp 220. We excluded these pixels when calculating the error map uncertainty.

*NGC 3031* - The 160  $\mu\text{m}$  image includes residual cirrus emission between the D<sub>25</sub> isophote and the measurement aperture that was masked out when calculating the 160  $\mu\text{m}$  flux density. See Sollima et al. (2010) and Davies et al. (2010b) for details on the features.

*NGC 3034* - The galaxy saturates the MIPS detectors in all three bands and causes unusually severe artefacts to appear in the data, and so we report no photometric measurements for this galaxy.

*NGC 4038/4039* - The 70  $\mu\text{m}$  image is strongly affected by streaking from latent image effects.

*NGC 5128* - The centre of the galaxy produced latent image effects that appear as a broad streak in the final image. The artefact was masked out when photometry was performed.

*NGC 5236* - The central 8 arcsec of the galaxy saturated the 24  $\mu\text{m}$  and 160  $\mu\text{m}$  data, but this region appears to contribute a relatively small fraction of the total emission from NGC 5236. We think the 24  $\mu\text{m}$  measurements should still be reliable to within the calibration uncertainty of 4%. As for the 160  $\mu\text{m}$  image, we interpolated across the single central saturated pixel to estimate the flux density for the pixel; the correction is much smaller than the calibration uncertainty.

#### Notes on the DGS data

*HS 0052+2536* - The 24  $\mu\text{m}$  image shows an unresolved 24  $\mu\text{m}$  source at the central position of HS 0052+2536 and an unresolved 24  $\mu\text{m}$  source with a similar surface brightness at the central position of HS 0052+2537, which is located  $\sim 15$  arcsec to the north. We masked out HS 0052+2537 when performing photometry.

*IC 10* - This galaxy was observed with MIPS only in the photometry map mode. However, the photometry map mode is intended for objects smaller than 5 arcmin, while the optical disc of IC 10 and the infrared emission from it are much more extended than this. While  $\gtrsim 90\%$  of the optical disc was covered at 24  $\mu\text{m}$ , only part of the galaxy was observed at 70 and 160  $\mu\text{m}$ , and a significant fraction of the infrared emission may have fallen outside

**Table 5.** Photometry for the Herscher Reference Survey

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
NGC 3226	3	10:23:27.4	+19:53:55	$3.2 \times 2.8$	$15^\circ$	24	0.0250	0.0010	0.0003	0.0006	0.0012
						70	0.459	0.046	0.009	0.011	0.048
						160					
NGC 3227	4	10:23:30.5	+19:51:54	$5.4 \times 3.6$	$155^\circ$	24	1.7173	0.0687	0.0067	0.0010	0.0690
						70	9.033	0.903	0.044	0.018	0.905
						160	18.19 <sup>f</sup>	2.18	0.05	0.02	2.18
NGC 3254	8	10:29:19.9	+29:29:31	$5.0 \times 1.6$	$46^\circ$	24	0.0927	0.0037	0.0005	0.0007	0.0038
						70					
						160					
NGC 3338	15	10:42:07.5	+13:44:49	$5.9 \times 3.6$	$100^\circ$	24	0.4578	0.0183	0.0003	0.0005	0.0183
						70					
						160					
NGC 3370	17	10:47:04.0	+17:16:25	$3.2 \times 1.8$	$148^\circ$	24	0.3836	0.0153	0.0005	0.0009	0.0154
						70	5.194	0.519	0.018	0.012	0.520
						160	10.30	1.24	0.02	0.02	1.24
NGC 3395 /3396 <sup>h</sup>	20 /(N/A)					24	1.1400	0.0456	0.0013	0.0010	0.0456
						70	11.927	1.193	0.025	0.027	1.193
						160	17.26	2.07	0.03	0.04	2.07
NGC 3414	22	10:51:16.2	+27:58:30	3.5		24	0.0430	0.0017	0.0004	0.0007	0.0019
						70	0.428	0.043	0.011	0.016	0.047
						160					
NGC 3424	23	10:51:46.3	+32:54:03	$2.8 \times 0.8$	$112^\circ$	24	0.7181	0.0287	0.0012	0.0005	0.0288
						70	9.398	0.940	0.035	0.012	0.941
						160	15.93	1.91	0.04	0.03	1.91
NGC 3430	24	10:52:11.4	+32:57:02	$4.0 \times 2.2$	$30^\circ$	24	0.4101	0.0164	0.0004	0.0006	0.0164
						70	5.683	0.568	0.015	0.021	0.569
						160	14.36	1.72	0.03	0.02	1.72
NGC 3448	31	10:54:39.2	+54:18:19	$5.6 \times 1.8$	$65^\circ$	24	0.5782	0.0231	0.0009	0.0005	0.0232
						70	6.730	0.673	0.024	0.012	0.673
						160	9.43 <sup>f</sup>	1.13	0.20	0.47	1.24
NGC 3485	33	11:00:02.3	+14:50:30	2.3		24	0.1853	0.0074	0.0002	0.0003	0.0074
						70	2.279	0.228	0.008	0.012	0.228
						160					
NGC 3499	35	11:03:11.0	+56:13:18	0.8		24	0.0124	0.0005	0.0001	0.0002	0.0005
						70					
						160					
NGC 3504	36	11:03:11.2	+27:58:21	2.7		24	3.0895	0.1236	0.0131	0.0003	0.1243
						70	19.268	1.927	0.089	0.017	1.929
						160	21.44	2.57	0.04	0.04	2.57
NGC 3512	37	11:04:02.9	+28:02:13	1.6		24	0.1365	0.0055	0.0001	0.0001	0.0055
						70	1.982	0.198	0.007	0.010	0.199
						160					
NGC 3608	43	11:16:58.9	+18:08:55	$3.2 \times 2.6$	$75^\circ$	24	0.0223	0.0009	0.0002	0.0004	0.0010
						70	< 0.110				
						160	< 0.48				
NGC 3640	49	11:21:06.8	+03:14:05	$4.0 \times 3.2$	$100^\circ$	24	0.0236	0.0009	0.0003	0.0006	0.0011
						70	< 0.137				
						160	< 0.72				
NGC 3655	50	11:22:54.6	+16:35:25	$1.5 \times 1.0$	$30^\circ$	24	0.7768	0.0311	0.0002	0.0001	0.0311
						70					
						160					
NGC 3659	51	11:23:45.5	+17:49:07	$2.1 \times 1.1$	$60^\circ$	24	0.1419	0.0057	0.0002	0.0003	0.0057
						70					
						160					
NGC 3666	53	11:24:26.0	+11:20:32	$4.4 \times 1.2$	$100^\circ$	24	0.2577	0.0103	0.0003	0.0004	0.0103
						70					
						160					
NGC 3681	54	11:26:29.8	+16:51:47	2.5		24	0.0772	0.0031	0.0002	0.0003	0.0031
						70	1.374	0.137	0.008	0.012	0.138
						160					

**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
NGC 3683	56	11:27:31.8	+56:52:37	$1.9 \times 0.7$	$128^\circ$	24 70 160	1.1755	0.0470	0.0003	0.0001	0.0470
NGC 3686	57	11:27:43.9	+17:13:27	$3.2 \times 2.5$	$15^\circ$	24 70 160	0.5463	0.0219	0.0004	0.0004	0.0219
NGC 3729	60	11:33:49.3	+53:07:32	$2.8 \times 1.9$	$15^\circ$	24 70 160	0.4591	0.0184	0.0012	0.0002	0.0184
NGC 3945	71	11:53:13.7	+60:40:32	$5.2 \times 3.5$	$165^\circ$	24 70 160	0.0914 0.456 3.30 <sup>f</sup>	0.0037 0.046 0.40	0.0003 0.012 0.01	0.0005 0.020 0.01	0.0037 0.051 0.40
NGC 3953	73	11:53:48.9	+52:19:36	$6.9 \times 3.5$	$13^\circ$	24 70 160	1.0606 12.034 47.64	0.0424 1.203 5.72	0.0006 0.025 0.05	0.0009 0.036 0.06	0.0424 1.204 5.72
NGC 3982	74	11:56:28.1	+55:07:31	2.3		24 70 160	0.7506 9.222 14.39	0.0300 0.922 1.73	0.0008 0.024 0.03	0.0006 0.012 0.02	0.0300 0.923 1.73
NGC 4030	77	12:00:23.6	-01:06:00	$4.2 \times 3.0$	$27^\circ$	24 70 160	1.9186 18.994 57.33	0.0767 1.899 6.88	0.0005 0.046 1.19	0.0004 0.011 0.03	0.0767 1.900 6.98
KUG 1201 +163	82	12:03:35.9	+16:03:20	$1.0 \times 1.0$	$0^\circ$	24 70 160	0.0596	0.0024	0.0002	0.0003	0.0024
NGC 4116	86	12:07:37.1	+02:41:26	$3.8 \times 2.2$	$155^\circ$	24 70 160	0.2172	0.0087	0.0003	0.0004	0.0087
NGC 4178	89	12:12:46.4	+10:51:57	$5.1 \times 1.8$	$30^\circ$	24 70 160	0.3898 5.138 14.16	0.0156 0.514 1.70	0.0003 0.011 0.03	0.0004 0.011 0.02	0.0156 0.514 1.70
NGC 4192	91	12:13:48.2	+14:54:01	$9.8 \times 2.8$	$155^\circ$	24 70 160	1.0139 11.914 42.78 <sup>g</sup>	0.0406 1.191 5.13	0.0006 0.046 0.04	0.0007 0.023 0.06	0.0406 1.193 5.13
NGC 4203	93	12:15:05.0	+33:11:50	$3.4 \times 3.2$	$10^\circ$	24 70 160	0.0759 0.895 4.11	0.0030 0.090 0.49	0.0004 0.013 0.01	0.0006 0.017 0.02	0.0031 0.092 0.49
NGC 4207	95	12:15:30.4	+09:35:06	$1.6 \times 0.8$	$124^\circ$	24 70 160	0.2359	0.0094	0.0003	0.0003	0.0094
NGC 4208	96	12:15:39.3	+13:54:05	$3.2 \times 1.9$	$75^\circ$	24 70 160	0.7779 9.041 20.97	0.0311 0.904 2.52	0.0009 0.040 0.03	0.0006 0.015 0.02	0.0311 0.905 2.52
NGC 4237	100	12:17:11.4	+15:19:26	$2.1 \times 1.3$	$108^\circ$	24 70 160	0.3020	0.0121	0.0002	0.0003	0.0121
NGC 4251	101	12:18:08.3	+28:10:31	$3.6 \times 1.5$	$100^\circ$	24 70 160	0.0259 < 0.082 < 0.13	0.0010	0.0003	0.0005	0.0012
NGC 4254	102	12:18:49.6	+14:24:59	5.4		24 70 160	4.2582 44.920 123.29	0.1703 4.492 14.80	0.0008 0.051 0.72	0.0008 0.023 0.05	0.1703 4.492 14.81
NGC 4260	103	12:19:22.2	+06:05:55	$2.7 \times 1.3$	$58^\circ$	24 70 160	0.0290 0.375 1.38	0.0012 0.037 0.17	0.0002 0.010 0.01	0.0003 0.009 0.02	0.0012 0.040 0.17
NGC 4262	105	12:19:30.5	+14:52:40	1.9		24 70 160	0.0182 < 0.152 < 0.35	0.0007	0.0002	0.0003	0.0008
NGC 4294	110	12:21:17.8	+11:30:38	$3.2 \times 1.2$	$155^\circ$	24 70 160	0.2259 3.860 6.69	0.0090 0.386 0.80	0.0002 0.009 0.02	0.0003 0.008 0.02	0.0090 0.386 0.80

**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
NGC 4298	111	12:21:32.7	+14:36:22	$3.2 \times 1.8$	$140^\circ$	24	0.5129	0.0205	0.0002	0.0003	0.0205
						70	5.672	0.567	0.010	0.008	0.567
						160	19.18	2.30	0.03	0.01	2.30
NGC 4302	113	12:21:42.4	+14:35:54	$5.5 \times 1.0$	$178^\circ$	24	0.4855	0.0194	0.0002	0.0004	0.0194
						70	6.286	0.629	0.014	0.010	0.629
						160	26.88	3.23	0.03	0.02	3.23
NGC 4303	114	12:21:54.8	+04:28:25	6.5		24	3.9380	0.1575	0.0021	0.0029	0.1576
						70					
						160	99.78 <sup>f</sup>	11.97	0.20	0.04	11.98
NGC 4305	116	12:22:03.6	+12:44:27	$2.2 \times 1.2$	$32^\circ$	24	< 0.0043				
						70	< 0.128				
						160	< 0.21 <sup>g</sup>				
NGC 4312	119	12:22:31.3	+15:32:17	$4.6 \times 1.1$	$170^\circ$	24	0.2225	0.0089	0.0004	0.0004	0.0089
						70	3.070	0.307	0.016	0.009	0.308
						160					
NGC 4313	120	12:22:38.5	+11:48:03	$4.0 \times 1.0$	$143^\circ$	24	0.1512	0.0060	0.0004	0.0006	0.0061
						70	1.666	0.167	0.010	0.010	0.167
						160	5.42 <sup>g</sup>	0.65	0.02	0.04	0.65
NGC 4321	122	12:22:54.9	+15:49:21	$7.4 \times 6.3$	$30^\circ$	24	3.4082	0.1363	0.0009	0.0009	0.1363
						70	36.015	3.602	0.066	0.028	3.602
						160	123.21	14.79	0.43	0.04	14.79
NGC 4330	124	12:23:17.2	+11:22:05	$4.5 \times 0.9$	$59^\circ$	24	0.1086	0.0043	0.0002	0.0003	0.0044
						70	1.382	0.138	0.007	0.009	0.139
						160	4.77	0.57	0.02	0.01	0.57
IC 3259	128	12:23:48.5	+07:11:13	$1.7 \times 0.9$	$15^\circ$	24					
						70	< 0.107				
						160					
NGC 4350	129	12:23:57.8	+16:41:36	$3.0 \times 1.4$	$28^\circ$	24	0.0370	0.0015	0.0001	0.0002	0.0015
						70	0.641	0.064	0.006	0.008	0.065
						160	1.06	0.13	0.01	0.02	0.13
NGC 4351	130	12:24:01.5	+12:12:17	$2.0 \times 1.3$	$80^\circ$	24	0.0635	0.0025	0.0002	0.0003	0.0026
						70	0.951	0.095	0.005	0.006	0.095
						160	2.41	0.29	0.01	0.01	0.29
NGC 4356	134	12:24:14.5	+08:32:09	$2.8 \times 0.5$	$40^\circ$	24	0.0890	0.0036	0.0007	0.0008	0.0037
						70	0.650	0.065	0.018	0.023	0.071
						160	1.93	0.23	0.01	0.02	0.23
NGC 4365	135	12:24:28.2	+07:19:03	$6.9 \times 5.0$	$40^\circ$	24	0.0571	0.0023	0.0010	0.0015	0.0029
						70	< 0.352				
						160	< 1.03 <sup>g</sup>				
NGC 4370	136	12:24:54.9	+07:26:42	$1.4 \times 0.7$	$83^\circ$	24	0.0483	0.0019	0.0005	0.0007	0.0021
						70	1.284	0.128	0.023	0.019	0.132
						160	2.88 <sup>g</sup>	0.35	0.01	0.02	0.35
NGC 4371	137	12:24:55.4	+11:42:15	$4.0 \times 2.2$	$95^\circ$	24	0.0251	0.0010	0.0007	0.0010	0.0016
						70	0.123	0.012	0.005	0.006	0.014
						160	< 0.27 <sup>g</sup>				
NGC 4374	138	12:25:03.7	+12:53:13	$6.5 \times 5.6$	$135^\circ$	24	0.1299	0.0052	0.0005	0.0011	0.0053
						70	0.584	0.058	0.027	0.033	0.072
						160	0.99 <sup>g</sup>	0.12	0.02	0.04	0.13
NGC 4376	139	12:25:18.0	+05:44:28	$1.4 \times 0.9$	$157^\circ$	24	0.0467	0.0019	0.0002	0.0003	0.0019
						70	0.790	0.079	0.008	0.008	0.080
						160	2.04	0.24	0.01	0.02	0.25
NGC 4378	140	12:25:18.1	+04:55:31	$2.9 \times 2.7$	$167^\circ$	24	0.0820	0.0033	0.0005	0.0007	0.0034
						70					
						160					
NGC 4380	141	12:25:22.2	+10:00:57	$3.5 \times 1.9$	$153^\circ$	24	0.1301	0.0052	0.0002	0.0003	0.0052
						70	1.237	0.124	0.006	0.009	0.124
						160	6.25	0.75	0.02	0.01	0.75
NGC 4383	142	12:25:25.5	+16:28:12	$1.9 \times 1.0$	$28^\circ$	24	0.9641	0.0386	0.0010	0.0002	0.0386
						70	1.237	0.124	0.006	0.009	0.124
						160	9.10	1.09	0.02	0.01	1.09

**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu\text{m}$ )	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
IC 3322A	143	12:25:42.5	+07:13:00	$3.5 \times 0.4$	$157^\circ$	24	0.1816	0.0073	0.0007	0.0009	0.0074
						70	2.872	0.287	0.023	0.024	0.289
						160	7.97 <sup>g</sup>	0.96	0.04	0.05	0.96
NGC 4388	144	12:25:46.7	+12:39:44	$5.6 \times 1.3$	$92^\circ$	24	2.5714	0.1029	0.0041	0.0004	0.1029
						70	10.730	1.073	0.029	0.010	1.073
						160	16.08	1.93	0.20	0.02	1.94
NGC 4390	145	12:25:50.6	+10:27:33	$1.7 \times 1.3$	$95^\circ$	24	0.0775	0.0031	0.0004	0.0006	0.0032
						70	0.980	0.098	0.005	0.007	0.098
						160	2.12 <sup>g</sup>	0.25	0.01	0.03	0.26
IC 3322	146	12:25:54.1	+07:33:17	$2.3 \times 0.5$	$156^\circ$	24	0.0603	0.0024	0.0005	0.0007	0.0026
						70	1.000	0.100	0.017	0.020	0.103
						160	2.23 <sup>g</sup>	0.27	0.02	0.02	0.27
NGC 4396	148	12:25:58.8	+15:40:17	$3.3 \times 1.0$	$125^\circ$	24	0.1290	0.0052	0.0002	0.0003	0.0052
						70	2.090	0.209	0.006	0.008	0.209
						160	4.95	0.59	0.02	0.01	0.59
NGC 4402	149	12:26:07.5	+13:06:46	$3.9 \times 1.1$	$90^\circ$	24	0.6473	0.0259	0.0002	0.0003	0.0259
						70	8.281	0.828	0.017	0.010	0.828
						160	22.05	2.65	0.04	0.02	2.65
NGC 4406	150	12:26:11.7	+12:56:46	$8.9 \times 5.8$	$130^\circ$	24	0.1221	0.0049	0.0003	0.0005	0.0049
						70	< 0.204				
						160	0.97 <sup>g</sup>	0.12	0.03	0.02	0.12
NGC 4407	151	12:26:32.2	+12:36:40	$2.3 \times 1.5$	$60^\circ$	24	0.1445	0.0058	0.0002	0.0003	0.0058
						70	1.381	0.138	0.005	0.008	0.138
						160	3.78	0.45	0.01	0.01	0.45
NGC 4412	152	12:26:36.0	+03:57:53	1.4		24	0.4029	0.0161	0.0011	0.0003	0.0162
						70					
						160					
NGC 4416	153	12:26:46.7	+07:55:08	1.7		24	0.1114	0.0045	0.0005	0.0007	0.0045
						70	1.506	0.151	0.016	0.019	0.153
						160	3.44 <sup>g</sup>	0.41	0.02	0.02	0.41
NGC 4411B	154	12:26:47.2	+08:53:05	2.5		24	0.0601	0.0024	0.0006	0.0008	0.0026
						70	1.188	0.119	0.017	0.022	0.122
						160	2.79 <sup>g</sup>	0.34	0.02	0.02	0.34
NGC 4417	155	12:26:50.6	+09:35:03	$3.4 \times 1.3$	$49^\circ$	24	0.0213	0.0009	0.0006	0.0009	0.0014
						70	< 0.115				
						160	< 0.26 <sup>g</sup>				
NGC 4419	156	12:26:56.4	+15:02:51	$3.3 \times 1.1$	$133^\circ$	24	1.2483	0.0499	0.0022	0.0003	0.0500
						70	8.091	0.809	0.032	0.008	0.810
						160	13.71	1.65	0.03	0.02	1.65
NGC 4409	157	12:26:58.5	+02:29:40	$2.0 \times 1.0$	$8^\circ$	24	0.2485	0.0099	0.0002	0.0003	0.0099
						70					
						160					
NGC 4424	159	12:27:11.5	+09:25:14	$3.6 \times 1.8$	$95^\circ$	24	0.3235	0.0129	0.0004	0.0003	0.0130
						70	3.636	0.364	0.014	0.008	0.364
						160	5.19	0.62	0.02	0.01	0.62
NGC 4429	161	12:27:26.5	+11:06:28	$5.6 \times 2.6$	$99^\circ$	24	0.1452	0.0058	0.0010	0.0014	0.0060
						70	2.856	0.286	0.039	0.037	0.291
						160	4.45 <sup>g</sup>	0.53	0.26	0.05	0.60
NGC 4435	162	12:27:40.4	+13:04:44	$2.8 \times 2.0$	$13^\circ$	24	0.1342	0.0054	0.0002	0.0003	0.0054
						70	2.569	0.257	0.014	0.008	0.257
						160	4.20	0.50	0.02	0.01	0.50
NGC 4438	163	12:27:45.5	+13:00:32	$8.5 \times 3.2$	$27^\circ$	24	0.3026	0.0121	0.0004	0.0006	0.0121
						70	5.932	0.593	0.024	0.018	0.594
						160	15.01	1.80	0.04	0.02	1.80
NGC 4440	164	12:27:53.5	+12:17:36	1.9		24	0.0191	0.0008	0.0005	0.0007	0.0011
						70	< 0.117				
						160	< 0.11 <sup>g</sup>				
NGC 4442	166	12:28:03.8	+09:48:13	$4.6 \times 1.8$	$87^\circ$	24	0.0429	0.0017	0.0003	0.0006	0.0018
						70	< 0.057				
						160	< 0.47				

**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
NGC 4445	167	12:28:15.9	+09:26:10	$2.6 \times 0.5$	$106^\circ$	24	0.0366	0.0015	0.0006	0.0008	0.0018
						70	0.538	0.054	0.012	0.017	0.058
						160	1.62 <sup>g</sup>	0.19	0.02	0.07	0.21
UGC 7590	168	12:28:18.7	+08:43:46	$1.3 \times 0.4$	$168^\circ$	24	0.0320	0.0013	0.0005	0.0007	0.0015
						70	0.528	0.053	0.015	0.019	0.058
						160	0.94 <sup>g</sup>	0.11	0.01	0.02	0.11
NGC 4450	170	12:28:29.6	+17:05:06	$5.2 \times 3.9$	$175^\circ$	24	0.2089	0.0084	0.0004	0.0006	0.0084
						70	2.890	0.289	0.013	0.015	0.290
						160	13.54	1.62	0.02	0.03	1.62
NGC 4451	171	12:28:40.5	+09:15:32	$1.5 \times 1.0$	$162^\circ$	24	0.1504	0.0060	0.0005	0.0007	0.0061
						70	2.497	0.250	0.023	0.018	0.251
						160	4.48 <sup>g</sup>	0.54	0.02	0.02	0.54
IC 3392	172	12:28:43.2	+14:59:58	$2.3 \times 1.0$	$40^\circ$	24	0.1184	0.0047	0.0002	0.0003	0.0047
						70	1.579	0.158	0.007	0.007	0.158
						160	3.64	0.44	0.09	0.02	0.45
NGC 4457	173	12:28:59.0	+03:34:14	2.7		24	0.4012	0.0160	0.0005	0.0003	0.0161
						70	5.478	0.548	0.021	0.010	0.548
						160	9.16	1.10	0.02	0.01	1.10
NGC 4459	174	12:29:00.0	+13:58:43	$3.5 \times 2.7$	$110^\circ$	24	0.1292	0.0052	0.0008	0.0010	0.0053
						70	2.364	0.236	0.033	0.028	0.240
						160	3.71 <sup>g</sup>	0.45	0.02	0.06	0.45
NGC 4461	175	12:29:03.0	+13:11:02	$3.5 \times 1.4$	$9^\circ$	24	0.0222	0.0009	0.0005	0.0005	0.0011
						70	< 0.153				
						160	< 0.16 <sup>g</sup>				
NGC 4469	176	12:29:28.0	+08:44:60	$3.8 \times 1.3$	$89^\circ$	24	0.0876	0.0035	0.0007	0.0010	0.0037
						70	1.367	0.137	0.024	0.026	0.141
						160	3.24 <sup>g</sup>	0.39	0.02	0.08	0.40
NGC 4470	177	12:29:37.7	+07:49:27	$1.3 \times 0.9$	$0^\circ$	24	0.1511	0.0060	0.0003	0.0005	0.0061
						70	2.352	0.235	0.022	0.018	0.237
						160	3.93	0.47	0.02	0.01	0.47
NGC 4472	178	12:29:46.7	+08:00:02	$10.2 \times 8.3$	$155^\circ$	24	0.2047	0.0082	0.0013	0.0019	0.0082
						70	< 0.354				
						160	< 1.38 <sup>g</sup>				
NGC 4473	179	12:29:48.8	+13:25:46	$4.5 \times 2.5$	$100^\circ$	24	0.0335	0.0013	0.0003	0.0005	0.0014
						70	< 0.203				
						160	< 0.21 <sup>g</sup>				
NGC 4477	180	12:30:02.1	+13:38:12	$3.8 \times 3.5$	$15^\circ$	24	0.0518	0.0021	0.0005	0.0007	0.0022
						70	0.682	0.068	0.025	0.032	0.080
						160	0.81 <sup>g</sup>	0.10	0.02	0.05	0.11
NGC 4478	181	12:30:17.4	+12:19:43	$1.9 \times 1.6$	$140^\circ$	24	0.0256	0.0010	0.0005	0.0007	0.0013
						70	< 0.117				
						160	< 0.17				
NGC 4486	183	12:30:49.4	+12:23:28	8.3		24	0.2511	0.0100	0.0014	0.0020	0.0105
						70	0.429	0.043	0.028	0.042	0.066
						160	0.30 <sup>g</sup>	0.04	0.03	0.05	0.07
NGC 4491	184	12:30:57.1	+11:29:01	$1.7 \times 0.9$	$148^\circ$	24	0.3183	0.0127	0.0021	0.0007	0.0129
						70	2.490	0.249	0.038	0.019	0.253
						160	1.71 <sup>g</sup>	0.21	0.02	0.03	0.21
NGC 4492	185	12:30:59.7	+08:04:40	1.7		24	0.0415	0.0017	0.0005	0.0007	0.0019
						70	0.288	0.029	0.012	0.020	0.037
						160	1.62 <sup>g</sup>	0.19	0.01	0.02	0.20
NGC 4494	186	12:31:24.0	+25:46:30	4.8		24	0.0600	0.0024	0.0005	0.0007	0.0025
						70	0.342	0.034	0.015	0.017	0.041
						160	0.43 <sup>f</sup>	0.05	0.01	0.02	0.06
NGC 4496	187	12:31:39.2	+03:56:22	$4.0 \times 3.0$	$70^\circ$	24	0.4920	0.0197	0.0006	0.0006	0.0197
						70	5.956	0.596	0.022	0.025	0.597
						160	13.84	1.66	0.02	0.02	1.66
NGC 4498	188	12:31:39.5	+16:51:10	$3.0 \times 1.6$	$133^\circ$	24	0.1343	0.0054	0.0002	0.0002	0.0054
						70	2.050	0.205	0.006	0.008	0.205
						160	5.48	0.66	0.02	0.01	0.66

**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
IC 797	189	12:31:54.7	+15:07:26	$1.3 \times 0.9$	$108^\circ$	24	0.0731	0.0029	0.0002	0.0003	0.0029
						70	1.105	0.111	0.006	0.010	0.111
						160	2.31	0.28	0.01	0.02	0.28
NGC 4501	190	12:31:59.2	+14:25:14	$6.9 \times 3.7$	$140^\circ$	24	2.2216	0.0889	0.0004	0.0006	0.0889
						70	28.284	2.828	0.024	0.016	2.829
						160	98.41	11.81	0.08	0.04	11.81
NGC 4506	192	12:32:10.5	+13:25:11	$1.6 \times 1.1$	$110^\circ$	24	0.0126	0.0005	0.0005	0.0007	0.0010
						70	0.357	0.036	0.012	0.018	0.042
						160	0.34 <sup>g</sup>	0.04	0.01	0.02	0.05
NGC 4517	194	12:32:45.5	+00:06:54	$10.5 \times 1.5$	$83^\circ$	24	1.1476	0.0459	0.0007	0.0007	0.0459
						70	11.273	1.127	0.023	0.019	1.128
						160	45.06	5.41	0.11	0.03	5.41
NGC 4516	195	12:33:07.5	+14:34:30	$1.7 \times 1.0$	$0^\circ$	24	0.0077	0.0003	0.0005	0.0007	0.0009
						70					
						160	< 0.16 <sup>g</sup>				
NGC 4519	196	12:33:30.2	+08:39:17	$3.2 \times 2.5$	$145^\circ$	24	0.5386	0.0215	0.0023	0.0011	0.0217
						70	5.006	0.501	0.029	0.020	0.502
						160	8.44 <sup>g</sup>	1.01	0.04	0.03	1.01
NGC 4522	197	12:33:40.0	+09:10:30	$3.7 \times 1.0$	$33^\circ$	24	0.1542	0.0062	0.0002	0.0003	0.0062
						70	2.011	0.201	0.009	0.008	0.201
						160	5.53	0.66	0.02	0.01	0.66
IC 800	199	12:33:56.6	+15:21:17	$1.5 \times 1.1$	$148^\circ$	24	0.0421	0.0017	0.0002	0.0003	0.0017
						70	0.636	0.064	0.005	0.010	0.065
						160	1.35	0.16	0.01	0.03	0.16
NGC 4526	200	12:34:03.0	+07:41:57	$7.2 \times 2.4$	$113^\circ$	24	0.3144	0.0126	0.0009	0.0010	0.0126
						70	8.098 <sup>f</sup>	0.810	0.047	0.017	0.811
						160	11.84 <sup>f</sup>	1.42	0.03	0.04	1.42
IC 3510	202	12:34:14.8	+11:04:17	$0.9 \times 0.6$	$0^\circ$	24	< 0.0043				
						70	< 0.112				
						160	< 0.65 <sup>g</sup>				
NGC 4532	203	12:34:19.3	+06:28:04	$2.8 \times 1.1$	$160^\circ$	24	0.8125	0.0325	0.0004	0.0003	0.0325
						70	9.742	0.974	0.022	0.008	0.974
						160	12.93	1.55	0.02	0.02	1.55
NGC 4535	204	12:34:20.3	+08:11:52	$7.1 \times 5.0$	$0^\circ$	24	1.7829	0.0713	0.0024	0.0015	0.0714
						70	16.427	1.643	0.052	0.031	1.644
						160	58.76 <sup>g</sup>	7.05	0.05	0.05	7.05
NGC 4536	205	12:34:27.1	+02:11:16	$7.6 \times 3.2$	$130^\circ$	24	3.5045	0.1402	0.0047	0.0008	0.1403
						70	26.991	2.699	0.122	0.019	2.702
						160	49.47	5.94	0.05	0.03	5.94
NGC 4548	208	12:35:26.4	+14:29:47	$5.4 \times 4.3$	$150^\circ$	24	0.4331	0.0173	0.0003	0.0006	0.0173
						70	4.350	0.435	0.013	0.014	0.435
						160	26.01	3.12	0.03	0.03	3.12
NGC 4546	209	12:35:29.5	-03:47:35	$3.3 \times 1.4$	$78^\circ$	24	0.0498	0.0020	0.0003	0.0005	0.0021
						70	0.206	0.021	0.010	0.015	0.028
						160					
NGC 4550	210	12:35:30.6	+12:13:15	$3.3 \times 0.9$	$178^\circ$	24	0.0273	0.0011	0.0004	0.0005	0.0013
						70	0.406	0.041	0.018	0.022	0.050
						160	< 0.11 <sup>g</sup>				
NGC 4552	211	12:35:39.8	+12:33:23	5.1		24	0.0960	0.0038	0.0003	0.0006	0.0039
						70	0.119	0.012	0.009	0.011	0.019
						160	< 0.87 <sup>g</sup>				
NGC 4561	212	12:36:08.1	+19:19:21	$1.5 \times 1.3$	$30^\circ$	24	0.0805	0.0032	0.0001	0.0002	0.0032
						70	1.551	0.155	0.005	0.006	0.155
						160	2.50	0.30	0.01	0.01	0.30
NGC 4565	213	12:36:20.7	+25:59:16	$15.8 \times 2.1$	$136^\circ$	24	1.6495	0.0660	0.0005	0.0007	0.0660
						70	19.257	1.926	0.026	0.022	1.926
						160	86.49	10.38	0.07	0.03	10.38
NGC 4564	214	12:36:26.9	+11:26:22	$3.5 \times 1.5$	$47^\circ$	24	0.0138	0.0006	0.0006	0.0009	0.0012
						70	< 0.168				
						160	< 0.14 <sup>g</sup>				



**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
NGC 4567 /4568 <sup>h</sup>	215 /216					24	2.0960	0.0838	0.0019	0.0020	0.0839
						70	27.005	2.700	0.109	0.054	2.703
						160	68.02 <sup>g</sup>	8.16	0.49	0.05	8.18
NGC 4569	217	12:36:49.7	+13:09:46	$9.5 \times 4.4$	23°	24	1.4279	0.0571	0.0019	0.0009	0.0572
						70	11.451	1.145	0.041	0.021	1.146
						160	35.98	4.32	0.05	0.05	4.32
NGC 4570	218	12:36:53.4	+07:14:48	$3.8 \times 1.1$	159°	24	0.0287	0.0011	0.0002	0.0003	0.0012
						70	< 0.047				
						160	< 0.07				
NGC 4578	219	12:37:30.5	+09:33:18	$3.3 \times 2.5$	35°	24	0.0206	0.0008	0.0003	0.0006	0.0011
						70	< 0.119				
						160	< 0.30				
NGC 4579	220	12:37:43.6	+11:49:05	$5.9 \times 4.7$	95°	24	0.8077	0.0323	0.0007	0.0008	0.0323
						70	9.585	0.958	0.020	0.019	0.959
						160	36.16	4.34	0.30	0.05	4.35
NGC 4580	221	12:37:48.3	+05:22:07	$2.1 \times 1.6$	165°	24	0.1448	0.0058	0.0002	0.0003	0.0058
						70	1.937	0.194	0.007	0.007	0.194
						160	5.65	0.68	0.02	0.01	0.68
NGC 4584	222	12:38:17.8	+13:06:36	5.1		24	0.0751	0.0030	0.0022	0.0029	0.0047
						70					
						160	0.60 <sup>g</sup>	0.07	0.01	0.03	0.08
NGC 4592	227	12:39:18.7	-00:31:55	$5.8 \times 1.5$	97°	24	0.1504	0.0060	0.0004	0.0005	0.0061
						70					
						160					
NGC 4596	231	12:39:55.9	+10:10:34	$4.0 \times 3.0$	135°	24	0.0554	0.0022	0.0005	0.0007	0.0024
						70	0.650	0.065	0.025	0.033	0.077
						160					
NGC 4606	232	12:40:57.5	+11:54:44	$3.2 \times 1.6$	33°	24	0.0877	0.0035	0.0002	0.0003	0.0035
						70	1.335	0.133	0.008	0.008	0.134
						160	2.80	0.34	0.05	0.02	0.34
NGC 4607	233	12:41:12.4	+11:53:12	$2.9 \times 0.7$	2°	24	0.2676	0.0107	0.0002	0.0002	0.0107
						70	4.108	0.411	0.013	0.007	0.411
						160	8.55	1.03	0.05	0.01	1.03
NGC 4612	235	12:41:32.7	+07:18:53	$2.5 \times 1.9$	145°	24	0.0139	0.0006	0.0002	0.0005	0.0008
						70	< 0.101				
						160	< 0.11				
NGC 4621	236	12:42:02.3	+11:38:49	$5.4 \times 3.7$	165°	24	0.1028	0.0041	0.0011	0.0015	0.0045
						70	< 0.240				
						160	< 0.83 <sup>g</sup>				
NGC 4630	237	12:42:31.1	+03:57:37	$1.8 \times 1.3$	10°	24	0.2877	0.0115	0.0006	0.0003	0.0115
						70					
						160					
NGC 4638	240	12:42:47.4	+11:26:33	$2.2 \times 1.4$	125°	24	0.0159	0.0006	0.0003	0.0004	0.0008
						70	< 0.110				
						160	< 0.25				
NGC 4636	241	12:42:49.8	+02:41:16	$6.0 \times 4.7$	150°	24	0.1134	0.0045	0.0009	0.0014	0.0048
						70					
						160	0.40	0.05	0.01	0.01	0.05
NGC 4639	242	12:42:52.3	+13:15:27	$2.8 \times 1.9$	123°	24	0.1554	0.0062	0.0003	0.0006	0.0062
						70					
						160	3.55 <sup>g</sup>	0.43	0.12	0.13	0.46
NGC 4647	244	12:43:32.3	+11:34:55	$2.9 \times 2.3$	125°	24	0.6396	0.0256	0.0006	0.0008	0.0256
						70	7.480	0.748	0.030	0.021	0.749
						160	16.30 <sup>g</sup>	1.96	0.14	0.15	1.97
NGC 4649	245	12:43:39.9	+11:33:10	$7.4 \times 6.0$	105°	24	0.1758	0.0070	0.0010	0.0014	0.0075
						70	< 0.570				
						160	< 1.95 <sup>g</sup>				
NGC 4651	246	12:43:42.6	+16:23:36	$4.0 \times 2.6$	80°	24	0.5691	0.0228	0.0002	0.0003	0.0228
						70	7.818	0.782	0.014	0.009	0.782
						160	20.72	2.49	0.03	0.02	2.49

**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu\text{m}$ )	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	Total
NGC 4654	247	12:43:56.5	+13:07:36	$4.9 \times 2.8$	$128^\circ$	24	1.6726	0.0669	0.0005	0.0004	0.0669
						70	19.503	1.950	0.021	0.012	1.950
						160	48.60	5.83	0.07	0.02	5.83
NGC 4660	248	12:44:31.9	+11:11:26	$2.2 \times 1.6$	$100^\circ$	24	0.0173	0.0007	0.0001	0.0001	0.0007
						70	< 0.072				
						160	< 0.05 <sup>g</sup>				
IC 3718	249	12:44:45.9	+12:21:05	$2.7 \times 1.0$	$72^\circ$	24	< 0.0104				
						70	< 0.232				
						160	< 0.85				
NGC 4666	251	12:45:08.5	-00:27:43	$4.6 \times 1.3$	$42^\circ$	24	3.2683	0.1307	0.0018	0.0008	0.1307
						70					
						160					
NGC 4688	252	12:47:46.5	+04:20:10	3.2		24	0.1753	0.0070	0.0005	0.0006	0.0071
						70					
						160					
NGC 4689	254	12:47:45.5	+13:45:46	4.3		24	0.4682	0.0187	0.0003	0.0004	0.0187
						70	4.949	0.495	0.011	0.015	0.495
						160	17.45	2.09	0.04	0.02	2.09
NGC 4698	257	12:48:22.9	+08:29:14	$4.0 \times 2.5$	$170^\circ$	24	0.1173	0.0047	0.0002	0.0003	0.0047
						70	0.688	0.069	0.007	0.010	0.070
						160	5.41	0.65	0.02	0.02	0.65
NGC 4697	258	12:48:35.9	-05:48:03	$7.2 \times 4.7$	$70^\circ$	24	0.0786	0.0031	0.0009	0.0012	0.0035
						70	0.502	0.050	0.028	0.031	0.065
						160	1.32	0.16	0.09	0.04	0.19
NGC 4701	259	12:49:11.5	+03:23:19	$2.8 \times 2.1$	$45^\circ$	24	0.2414	0.0097	0.0003	0.0004	0.0097
						70					
						160					
NGC 4725	263	12:50:26.6	+25:30:03	$10.7 \times 7.6$	$35^\circ$	24	0.8748	0.0350	0.0008	0.0012	0.0350
						70	7.469	0.747	0.023	0.028	0.748
						160	51.70	6.20	0.05	0.04	6.20
NGC 4754	269	12:52:17.5	+11:18:49	$4.6 \times 2.5$	$23^\circ$	24	0.0401	0.0016	0.0002	0.0004	0.0017
						70	< 0.065				
						160	< 0.82 <sup>f</sup>				
NGC 4762	272	12:52:56.0	+11:13:51	$8.7 \times 1.7$	$32^\circ$	24	0.0463	0.0019	0.0003	0.0004	0.0019
						70	< 0.072				
						160	< 0.17 <sup>f</sup>				
NGC 4772	274	12:53:29.1	+02:10:06	$3.4 \times 1.7$	$147^\circ$	24	0.0568	0.0023	0.0003	0.0005	0.0023
						70	0.748	0.075	0.011	0.015	0.077
						160					
UGC 8041	279	12:55:12.6	+00:06:60	$3.1 \times 1.9$	$165^\circ$	24	0.0859	0.0034	0.0002	0.0004	0.0035
						70					
						160					
NGC 4808	283	12:55:48.9	+04:18:15	$2.8 \times 1.1$	$127^\circ$	24	0.6398	0.0256	0.0003	0.0002	0.0256
						70	8.688	0.869	0.018	0.008	0.869
						160	15.99	1.92	0.03	0.01	1.92
NGC 4941	288	13:04:13.1	-05:33:06	$3.6 \times 1.9$	$15^\circ$	24	0.4272	0.0171	0.0010	0.0007	0.0171
						70	1.845	0.184	0.021	0.034	0.189
						160					
NGC 5147	293	13:26:19.7	+02:06:03	$1.9 \times 1.5$	$120^\circ$	24	0.2554	0.0102	0.0003	0.0005	0.0102
						70	4.023	0.402	0.010	0.012	0.403
						160	6.18	0.74	0.02	0.02	0.74
NGC 5248	295	13:37:32.0	+08:53:06	$6.2 \times 4.5$	$110^\circ$	24	2.4003	0.0960	0.0016	0.0013	0.0960
						70	28.384	2.838	0.081	0.028	2.840
						160	66.48	7.98	0.19	0.05	7.98
NGC 5273	296	13:42:08.3	+35:39:15	$2.8 \times 2.5$	$10^\circ$	24	0.1076	0.0043	0.0006	0.0004	0.0044
						70	0.817	0.082	0.011	0.015	0.084
						160	0.91	0.11	0.01	0.02	0.11
NGC 5303	298	13:47:44.9	+38:18:17	$0.9 \times 0.4$	$92^\circ$	24	0.2983	0.0119	0.0003	0.0002	0.0119
						70					
						160					

**Table 5.** Photometry for the Herscher Reference Survey (continued)

Galaxy	HRS Number <sup>a</sup>	R. A. (J2000) <sup>b</sup>	Optical Disc		Position Angle <sup>cd</sup>	Wave- length ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Uncertainty (Jy) <sup>e</sup>			Total
			Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>				Calibration	Error Map	Back- ground	
NGC 5363	306	13:56:07.2	+05:15:17	$4.1 \times 2.6$	$135^\circ$	24	0.1421	0.0057	0.0004	0.0007	0.0057
						70	2.167	0.217	0.030	0.018	0.220
						160	4.54	0.54	0.12	0.04	0.56
NGC 5576	312	14:21:03.6	+03:16:16	$3.5 \times 2.2$	$95^\circ$	24	0.0270	0.0011	0.0003	0.0006	0.0013
						70	< 0.096				
						160	< 0.33 <sup>f</sup>				
NGC 5577	313	14:21:13.1	+03:26:09	$3.4 \times 1.0$	$56^\circ$	24	0.0879	0.0035	0.0003	0.0003	0.0035
						70					
						160					
NGC 5669	319	14:32:43.4	+09:53:26	$4.0 \times 2.8$	$50^\circ$	24	0.1959	0.0078	0.0004	0.0007	0.0079
						70	3.006	0.301	0.024	0.036	0.304
						160	7.83	0.94	0.01	0.03	0.94
NGC 5668	320	14:33:24.3	+04:27:02	3.3		24	0.2561	0.0102	0.0004	0.0007	0.0103
						70	4.444	0.444	0.025	0.024	0.446
						160	11.49	1.38	0.02	0.02	1.38
NGC 5692	321	14:38:18.1	+03:24:37	$0.9 \times 0.6$	$35^\circ$	24	0.1163	0.0047	0.0005	0.0007	0.0047
						70	1.873	0.187	0.022	0.017	0.189
						160	2.07 <sup>g</sup>	0.25	0.18	0.09	0.32
IC 1048	323	14:42:58.0	+04:53:22	$2.2 \times 0.7$	$163^\circ$	24	0.1624	0.0065	0.0010	0.0013	0.0067
						70					
						160	5.08 <sup>g</sup>	0.61	0.15	0.12	0.64

<sup>a</sup> The HRS number corresponds to the numbers given by Boselli et al. (2010).

<sup>b</sup> Data are from NED.

<sup>c</sup> Data are from de Vaucouleurs et al. (1991) unless otherwise specified. If de Vaucouleurs et al. (1991) specify both the minor/major axis ratio and the position angle, then both axes and the position angle are listed. If de Vaucouleurs et al. (1991) did not specify either of these data, then we performed photometry on circular regions, and so only the major axis is specified.

<sup>d</sup> The position angle is defined as degrees from north through east.

<sup>e</sup> Details on the sources of these uncertainties are given in Section 3.1.

<sup>f</sup> These measurements are from data in which significant portions of the optical discs (> 10%) of the galaxies were not covered in this specific wave band. The measurements here are for the region that was covered in the MIPS data. We have applied no corrections for the missing flux density.

<sup>g</sup> These 160  $\mu$ m measurements are for galaxies that were covered in scan map observations in which the final 160  $\mu$ m images for these galaxies contain NaN values within the optical disc as a consequence of incomplete coverage. This typically occurs when scan maps are performed using the fast scan rate, although NaN values within the optical discs of galaxies occasionally appear in other data. The 160  $\mu$ m measurements for these galaxies is based upon interpolating over these pixels; see the text for details.

<sup>h</sup> These objects consist of two galaxies with optical discs that overlap. See Table 2 for the dimensions of the measurement apertures for these objects.

the observed regions. Given this, we will not report 70 and 160  $\mu$ m measurements for this galaxy.

*Mrk 153* - In the 160  $\mu$ m image, the galaxy becomes blended with another galaxy to the east. We therefore do not report 160  $\mu$ m flux densities for this galaxy.

*NGC 5253* - This is another case where the galaxy is unresolved in the MIPS bands and where the galaxy saturated the 24  $\mu$ m detector, which is why we report no 24  $\mu$ m flux density for this galaxy.

*NGC 6822* - The galaxy has an extension to the south (Cannon et al. 2006) that is not included within the optical disk given by de Vaucouleurs et al. (1991), so for photometry, we used a 30 arcmin diameter circle centered on the optical position of the galaxy given by NED. This galaxy also lies in a field with cirrus structure on the same size as the galaxy. The version of the 70 and 160  $\mu$ m data processing that we applied has removed the gradient in the cirrus emission present in this part of the sky, which causes the final map to appear significantly different from the SINGS version of the map for this specific galaxy.

*SBS 1249+493* - The 24  $\mu$ m image includes a bright central source and a fainter source  $\sim 12$  arcsec to the south. It is unclear

as to whether this source is associated with the galaxy; we masked it out before performing flux density measurements.

*Tol 0618-402* - The brightest feature in the 160  $\mu$ m photometry map image is a streak-like feature running from northwest to southeast near the location of the galaxy. It is unclear from this image alone if this is an artefact of the data processing or a real large-scale feature, although based on what we have seen in similar 160  $\mu$ m photometry map data, the latter may be more likely. No feature in the image appears to correspond to the source itself, and so we reported the integrated 160  $\mu$ m flux density within the 3 arcmin diameter aperture on the source as the upper limit on the emission, using regions flanking this region as the best background measurements available.

*Tol 1214-277* - We excluded a marginally-resolved source at approximately right ascension 12:17:17.7 and declination -28:02:56 from the 24 and 70  $\mu$ m measurements, as this is likely to be a background galaxy. However, the source became blended with Tol 1214-277 at 160  $\mu$ m, so we do not report 160  $\mu$ m flux density measurements for Tol 1214-277.

*II Zw 40* - The 160  $\mu$ m image contains only a few square arcmin of background. The 160  $\mu$ m background appears to contain a significant surface brightness gradient, which may be expected

**Table 6.** Photometry for additional Herschel Virgo Cluster Survey galaxies<sup>a</sup>

Galaxy	R. A. (J2000) <sup>b</sup>	Optical Disc Declination (J2000) <sup>b</sup>	Axes (arcmin) <sup>c</sup>	Position Angle <sup>cd</sup>	Wavelength ( $\mu$ m)	Flux Density Measurement (Jy)	Flux Density Calibration	Flux Density Error	Flux Density Uncertainty (Jy) <sup>e</sup> Background	Total
NGC 4165	12:12:11.7	+13:14:47	$1.3 \times 0.9$	$160^\circ$	24 70 160	0.0264	0.0011	0.0003	0.0004	0.0012
NGC 4234	12:17:09.1	+03:40:59	1.3		24 70 160	0.1547	0.0062	0.0002	0.0003	0.0062
NGC 4252	12:18:30.8	+05:33:34	$1.5 \times 0.4$	$48^\circ$	24 70 160	0.0098 0.183 0.46	0.0004 0.018 0.06	0.0002 0.005 0.00	0.0002 0.005 0.02	0.0005 0.020 0.06
NGC 4266	12:19:42.3	+05:32:18	$2.0 \times 0.4$	$76^\circ$	24 70 160	0.0329 0.494 2.04	0.0013 0.049 0.24	0.0004 0.007 0.01	0.0005 0.011 0.02	0.0015 0.051 0.25
NGC 4273	12:19:56.0	+05:20:36	$2.3 \times 1.5$	$10^\circ$	24 70 160	1.0295 12.387 18.50	0.0412 1.239 2.22	0.0011 0.030 0.03	0.0005 0.013 0.02	0.0412 1.239 2.22
NGC 4299	12:21:40.9	+11:30:12	$1.7 \times 1.6$	$26^\circ$	24 70 160	0.2350 3.346 4.32	0.0094 0.335 0.52	0.0002 0.008 0.02	0.0002 0.006 0.01	0.0094 0.335 0.52
NGC 4309	12:22:12.3	+07:08:40	$1.9 \times 1.1$	$85^\circ$	24 70 160	0.0620	0.0025	0.0003	0.0003	0.0025
IC 3258	12:23:44.4	+12:28:42	1.6		24 70 160	0.0764 0.776 0.87	0.0031 0.078 0.10	0.0005 0.014 0.01	0.0007 0.019 0.02	0.0032 0.081 0.11
NGC 4411	12:26:30.1	+08:52:20	2.0		24 70 160	0.0234 0.474 1.40	0.0009 0.047 0.17	0.0005 0.014 0.01	0.0006 0.017 0.01	0.0012 0.052 0.17
UGC 7557	12:27:11.0	+07:15:47	3.0		24 70 160	0.0326 0.659 1.55 <sup>f</sup>	0.0013 0.066 0.19	0.0007 0.020 0.03	0.0010 0.029 0.04	0.0018 0.075 0.19
NGC 4466	12:29:30.5	+07:41:47	$1.3 \times 0.4$	$101^\circ$	24 70 160	0.0243 0.602 1.13 <sup>f</sup>	0.0010 0.060 0.14	0.0005 0.014 0.01	0.0007 0.020 0.02	0.0013 0.065 0.14
IC 3476	12:32:41.8	+14:03:02	$2.1 \times 1.8$	$30^\circ$	24 70 160	0.1881 1.961 2.88 <sup>f</sup>	0.0075 0.196 0.35	0.0006 0.016 0.01	0.0007 0.019 0.02	0.0076 0.198 0.35
NGC 4531	12:34:15.8	+13:04:31	$3.1 \times 2.0$	$155^\circ$	24 70 160	0.0351 0.539 2.76 <sup>f</sup>	0.0014 0.054 0.33	0.0006 0.017 0.02	0.0009 0.023 0.04	0.0018 0.061 0.33

<sup>a</sup> These are galaxies that are not in the HRS but that appear in the 500  $\mu$ m-selected sample published by Davies et al. (2012).

<sup>b</sup> Data are from NED.

<sup>c</sup> Data are from de Vaucouleurs et al. (1991) unless otherwise specified. If de Vaucouleurs et al. (1991) specify both the minor/major axis ratio and the position angle, then both axes and the position angle are listed. If de Vaucouleurs et al. (1991) did not specify either of these data, then we performed photometry on circular regions, and so only the major axis is specified.

<sup>d</sup> The position angle is defined as degrees from north through east.

<sup>e</sup> Details on the sources of these uncertainties are given in Section 3.1.

<sup>f</sup> These 160  $\mu$ m measurements are for galaxies that were covered in scan map observations in which the final 160  $\mu$ m images for these galaxies contain NaN values within the optical disc as a consequence of incomplete coverage. This typically occurs when scan maps are performed using the fast scan rate, although NaN values within the optical discs of galaxies occasionally appear in other data. The 160  $\mu$ m measurements for these galaxies is based upon interpolating over these pixels; see the text for details.

given that the galaxy lies at a galactic latitude of  $\sim -11$ . Additionally, we had difficulty reproducing the 160  $\mu$ m flux density published by Engelbracht et al. (2008). Given this, we did not feel confident reporting a 160  $\mu$ m flux density for this source.

#### Notes on the HRS data

*NGC 4356* - The galaxy falls near a 24  $\mu$ m artefact we describe as also affecting the NGC 4472 data (see below). However, the fea-

ture appears relatively faint and broad in the vicinity of NGC 4356, and so we treat it as part of the background.

*NGC 4472* - The 24  $\mu$ m image in the scan map data from AORs 22484480, 22484736, 22484992, and 22455248 were affected by two streak-like regions that run roughly perpendicular to the scan map direction. These features do not appear in overlapping maps taken on other dates during the mission. We were unable to identify the origin of this line. All we can say is that the positions of these streaks vary with respect to the scan leg position and that the

width of the features is variable. One of these streak-like regions runs across the optical disc of NGC 4472, and we masked it out before making  $24\ \mu\text{m}$  flux density measurements.

*NGC 4486* - The  $160\ \mu\text{m}$  data within the optical disc of NGC 4486 were notably affected by residual striping in the images. Two strips approximately 3 arcmin in width to the north and south of the nucleus were affected and were masked out when the  $160\ \mu\text{m}$  flux density was measured.

*NGC 4526* - Both the  $70$  and  $160\ \mu\text{m}$  images cover only the central 3 arcmin of the galaxy, and the  $160\ \mu\text{m}$  image does not include a section on the western side of the optical disc that is 2 arcmin in width. However, the emission is relatively centralised, so these problems may not significantly affect the photometry.

*NGC 4552* - In the  $160\ \mu\text{m}$  data, a cirrus feature oriented roughly east-west can be seen crossing through the optical disc of this galaxy. We otherwise detect no  $160\ \mu\text{m}$  emission; we found no  $160\ \mu\text{m}$  counterparts to the  $24$  and  $70\ \mu\text{m}$  central source in this galaxy. Hence, we are reporting the integrated flux density as an upper limit even though we get a  $> 5\sigma$  detection for the integrated flux density within the optical disc and we detect surface brightness features at  $> 5\sigma$  level.

*NGC 4567/4568* - The  $70\ \mu\text{m}$  data near this galaxy are heavily affected by latent image effects.

*NGC 4636* - This is an elliptical galaxy with an optical disc with a size of  $6.0 \times 4.7$  arcmin (de Vaucouleurs et al. 1991). At  $160\ \mu\text{m}$ , we detect multiple off-center point sources within the optical disc of the galaxy that are approximately half the brightness of the central source and that do not appear to correspond to structure within the galaxy. We assume that the central source is associated with the galaxy and the off-central sources are background galaxies, but masking out the off-central sources was equivalent to masking out the equivalent of most of the optical disc. We therefore perform a  $160\ \mu\text{m}$  measurement within a circle with a diameter of 80 arcsec and then apply the multiplicative aperture correction of 1.745 given by Stansberry et al. (2007) for a 30 K source (which, among the spectra used to calculate aperture corrections, is the closest to the expected spectrum for this object).

*NGC 4647/4649* - While the optical disc of these two galaxies overlap, NGC 4649 produces relatively compact  $24\ \mu\text{m}$  emission and no detectable  $70$  or  $160\ \mu\text{m}$  emission. We assume that the optical disc of NGC 4647 contains negligible emission from NGC 4649. Hence, we are able to report separate flux densities for each source at  $24\ \mu\text{m}$ , flux densities for NGC 4647 at  $70$  and  $160\ \mu\text{m}$ , and upper limits for the  $70$  and  $160\ \mu\text{m}$  flux densities for NGC 4649 using the part of NGC 4649 that does not include NGC 4647. Also, the  $70\ \mu\text{m}$  image is strongly affected by latent image artefacts.

*NGC 4666* - This galaxy was observed in photometry map mode. The galaxy is observed in such a way that the latent image removal in the  $24\ \mu\text{m}$  data processing leaves a couple of NaN values near the center of the galaxy. These pixels correspond to locations between peaked emission, so it is clear that the data are not related to saturation of the detectors. We interpolated over these pixels before performing photometric measurements.

### 3.2 Comparisons of photometry to previously-published results

The MIPS calibration at this point is very well established, and comparisons between MIPS and IRAS photometry have already been performed (Engelbracht et al. 2007). Therefore, we believe that the most appropriate check of our photometry would be to

compare our measurements to other published MIPS photometry measurements. As indicated above, MIPS photometric measurements have previously been published for a significant fraction of the data that we used. While it is impractical to cite every paper that has been published based on the MIPS data for these galaxies, three papers have published MIPS data for significant subsets of galaxies in the SAG2 and HeViCS samples. We use these papers to check our data processing.

#### 3.2.1 Comparisons with SINGS data

SINGS was a survey with all of the *Spitzer* instruments that observed a cross-section of a representative sample of galaxies within 30 Mpc. A total of 15 galaxies from the SAG2 surveys and in HeViCS were originally observed with MIPS in SINGS. Preliminary photometry for the survey was published by Dale et al. (2005), while the final photometry was published by Dale et al. (2007). We compared our data to the data from Dale et al. (2007). However, we exclude NGC 5194/5195 because we are reporting one set of measurements for the system while Dale et al. report separate flux densities for each galaxy.

The ratio of the Dale et al. (2007)  $24\ \mu\text{m}$  flux densities to ours is  $0.97 \pm 0.08$ , which is very good. The largest outlier is NGC 6822, where we measure a  $\sim 30\%$  higher flux density than Dale et al. However, as we indicated above, this is a galaxy that is large in angular size and that has infrared emission that extends outside its optical disk. Additionally, the emission from foreground cirrus structure is relatively strong compared to the diffuse emission from the galaxy itself. Ultimately, this may be a case where measuring the diffuse emission from the target galaxy is simply fraught with uncertainty. Aside from this case, however, the comparison has produced very pleasing results.

In comparing the Dale et al. (2007)  $70\ \mu\text{m}$  flux densities to our own, we found one galaxy with a factor of  $\sim 5$  difference in the flux densities. This was NGC 4552, an elliptical galaxy with relatively weak emission from a central source. Dale et al. reported a flux density of  $0.52 \pm 0.11$  Jy for this galaxy, which is a factor of 5 higher than our measurement. The Dale et al. number could be a factor of 10 too high because of a typographical error; when we measured the flux density the SINGS Data Release 5 (DR5) data<sup>1</sup> using the same apertures that we used for our data, we obtained  $0.04 \pm 0.02$  Jy. This measurement from the SINGS data is a factor of 2 lower than the measurement from our mosaic. However, our image of this galaxy was made using both SINGS data and additional  $70\ \mu\text{m}$  data that was taken after the SINGS photometry was published, and so the measurement from our new mosaic may be more reliable.

At  $160\ \mu\text{m}$  for NGC 4552, we reported an upper limit that is a factor of  $\sim 1.5$  lower than the Dale et al. (2007) measurement. Again, we think our measurement could be more reliable because we combined SINGS data with other scan map data not available to Dale et al., and so the signal-to-noise in our data should be better.

Excluding NGC 4552, the ratio of the Dale et al. (2007)  $70\ \mu\text{m}$  flux densities to ours is  $1.11 \pm 0.07$ . At  $160\ \mu\text{m}$ , the ratio of the Dale et al. flux densities to ours is  $1.20 \pm 0.07$ . This shows that some systematic effects cause the Dale et al. measurements to be slightly higher than ours, although the agreement is close to the calibration uncertainty of the data, and the scatter in the ratios is very small.

<sup>1</sup> Available at [http://data.spitzer.caltech.edu/popular/sings/20070410\\_enhanced\\_v1/](http://data.spitzer.caltech.edu/popular/sings/20070410_enhanced_v1/).

If Dale et al. used the data in DR5, then their 160  $\mu\text{m}$  measurements would have been based on data in which the flux calibration factor is 5% higher than the one we used, which could explain part of the discrepancy at 160  $\mu\text{m}$ . However, this does not completely explain the discrepancy, and since the flux calibration factor in the SINGS DR5 70  $\mu\text{m}$  data is the same as ours, differences in the factor cannot explain the discrepancies in that wave band. Although we used data not available to Dale et al. to produce some of our images, we still see the systematic effects in the cases where we used exactly the same data as SINGS, so differences in the data used should not lead to differences in the photometry.

One possible cause for the systematic offsets in the photometry could be the differences in the way the short term drift was removed. The other possible cause is differences in the way flux densities were measured and handled. While we used relatively large apertures (1.5 times the  $D_{25}$  isophote) to measure flux densities, Dale et al. used the  $D_{25}$  isophotes as apertures and then applied aperture corrections. To check whether the data processing was the primary culprit for the discrepancy, we downloaded the SINGS DR5 data and performed photometry on those data using the same software and apertures that we had applied to our own (after correcting the 160  $\mu\text{m}$  flux calibration to match ours). The ratio of the measurements from the SINGS DR5 data to the measurements from our data is  $0.95 \pm 0.07$  at 70  $\mu\text{m}$  and  $1.08 \pm 0.04$  in the 160  $\mu\text{m}$  data. This shows that the measurement techniques are responsible for a significant part of the systematic offsets between the Dale et al. measurements and ours, while the data processing differences probably cause an additional offset in the 160  $\mu\text{m}$  data.

Overall, we are satisfied with how our measurements compares to the data from Dale et al. (2007). The scatter in the measurements is relatively small when difficult cases are excluded. The remaining differences are at levels that are comparable to the calibration uncertainties and that are in part related to the measurement techniques, and these differences probably reflect limitations in the photometric accuracy that can be achieved with MIPS data for nearby galaxies in general.

### 3.2.2 Comparisons with Engelbracht et al. (2008) data

Engelbracht et al. (2008) published data a survey of starburst galaxies that spanned a broad range of metallicities. 22 of the 66 galaxies overlap with the SAG2 sample: 21 of the galaxies are in the DGS, and NGC 5236 is in the VNGS. Although Engelbracht et al. applied colour corrections while we have not, it is still useful to compare the data.

The ratio of the Engelbracht et al. (2008) 24  $\mu\text{m}$  measurements to our 24  $\mu\text{m}$  measurements is  $1.00 \pm 0.13$ , indicating that our measurements agree with the Engelbracht et al. to within 13%. However, this includes some infrared-faint galaxies where both Engelbracht et al. and we report  $> 10\%$  uncertainties in the flux density measurements. If we use data where the 24  $\mu\text{m}$  flux densities from both datasets are  $> 0.1$  Jy, the ratio becomes  $1.00 \pm 0.05$ . The remaining dispersion is equivalent to the uncertainty in the flux calibration, which is very good.

Engelbracht et al report 24  $\mu\text{m}$  flux densities for two objects for which we do not report flux densities. For Tol 0618-402, we have reported an upper limit of 0.0015 Jy, while Engelbracht et al. have reported a  $\sim 4\sigma$  detection ( $(4.4 \pm 1.2) \times 10^{-4}$  Jy). We are reporting  $< 5\sigma$  detections as upper limits, so, given the signal-to-noise in the Engelbracht et al. measurement, we would not report a flux density for this galaxy. None the less, our upper limit for Tol 0618-402 is consistent with the Engelbracht et al. flux density.

The other object is NGC 5253, for which we reported no flux density measurement because the 24  $\mu\text{m}$  emission originates from an unresolved source that saturates the 24  $\mu\text{m}$  array. Engelbracht et al. report a flux density for this galaxy but made no special notes about it. Although the saturation may not be too difficult to deal with when measuring the flux density, we prefer to be more conservative and report no flux density for this object.

In comparing the Engelbracht et al. (2008) 70  $\mu\text{m}$  data to ours, we found one galaxy where the flux density measurements differ by a factor of 2. For Tol 1214-277, our 70  $\mu\text{m}$  flux density measurement is  $0.073 \pm 0.010$  Jy, whereas Engelbracht et al. report  $0.031 \pm 0.003$  Jy. The signal from the source is hardly  $5\sigma$  above the noise in our image of this galaxy. We also probably used a broader measurement aperture than Engelbracht et al. Engelbracht et al. used apertures that were adjusted to radii that encompassed all pixels with emission above a set signal-to-noise level, whereas we used a 3 arcmin diameter aperture, which was our standard aperture for point-like sources. Our aperture may have included additional signal not included by Engelbracht et al.

Excluding Tol 0618-402 (where we report an upper limit and Engelbracht et al. (2008) report a  $\sim 1.5$  detection) and Tol 1214-277 (discussed above), our 70  $\mu\text{m}$  flux density measurements agree well with those from Engelbracht et al. The ratio of the Engelbracht et al. (2008) 70  $\mu\text{m}$  measurements to ours is  $1.04 \pm 0.17$ . For sources above 1 Jy, where the signal-to-noise is primarily limited by the calibration uncertainty, the ratio is  $1.02 \pm 0.09$ , which is comparable to the calibration uncertainty of 10%.

A comparison of the Engelbracht et al. (2008) 160  $\mu\text{m}$  measurements with ours (for galaxies we detected above the  $5\sigma$  level and where we did not encounter problems with photometry) does not show agreement that is as good as for the 24 and 70  $\mu\text{m}$  data. Aside from non-detections, the ratio of the Engelbracht 160  $\mu\text{m}$  flux densities to ours is  $0.88 \pm 0.28$ . Measurements for UGC 4483 and UM 461 are particularly discrepant. We measure 160  $\mu\text{m}$  flux densities that are greater than a factor of 2 higher than the Engelbracht et al. measurements. However, these are very faint galaxies; the flux densities are  $< 0.2$  Jy. The Engelbracht et al. measurements are at the  $< 3\sigma$  level, and we used 160  $\mu\text{m}$  data that would have been unavailable when the Engelbracht et al. results were published, so the improved signal-to-noise in our data could have allowed us to make more accurate measurements for these faint galaxies. Excluding UGC 4483 and UM 461, the ratio of Engelbracht et al. 160  $\mu\text{m}$  measurements to ours is  $0.96 \pm 0.19$ . The scatter in the ratio is still larger than the calibration uncertainty of 12%, but this may reflect issues with simply measuring 160  $\mu\text{m}$  flux densities in the MIPS data for these dwarf galaxies, many of which are fainter than 1 Jy or in small fields. Additionally, the colour correction applied by Engelbracht et al. could have increased the dispersion in the ratios.

Overall, this comparison has shown excellent agreement between the 24 and 70  $\mu\text{m}$  flux densities measured by us and by Engelbracht et al. (2008). In the 160  $\mu\text{m}$  data, we found two discrepancies that cause some concern, but we think these are unique cases. Our 160  $\mu\text{m}$  flux densities for other DGS sources were in general agreement with the Engelbracht et al. measurements, thus demonstrating the reliability of our data reduction and photometry for these data.

### 3.2.3 Comparisons with Ashby et al. (2011) data

Ashby et al. (2011) published a multiwavelength survey of 369

nearby star-forming galaxies that includes 24  $\mu\text{m}$  data. 23 of the galaxies in the HRS and 2 of the additional HeViCS galaxies overlap with the galaxies in the Ashby et al. sample. Ashby et al. used SExtractor to measure flux densities and then applied appropriate aperture corrections, which is notably different from the aperture photometry that we applied.

We have one galaxy where our 24  $\mu\text{m}$  measurements differ notably from Ashby et al. (2011). For NGC 3430, we measured  $0.4101 \pm 0.0164$  Jy, but Ashby et al. measured  $0.17 \pm 0.01$  Jy. We used the same data as Ashby et al. to produce our image, so differences in the raw data cannot explain the difference in flux densities. An examination of the image does not reveal any indication of any problems with producing the image or making the photometric measurement. The IRAS 25  $\mu\text{m}$  flux density measurements of  $0.27 \pm 0.04$  Jy given by the Faint Source Catalog Moshir et al. (1990) and  $0.78 \pm 0.05$  Jy given by Surace et al. (2004) are also higher than the Ashby et al. measurements numbers but still disagree with ours and with each other. We ultimately suspect that the mismatching flux densities could be indicative of a problem with the Ashby et al. measurement obtained using SExtractor for this specific galaxy, as the Ashby et al. measurement is lower than all other measurements at this wavelength. Unfortunately, we do not have access to the final Ashby et al. images and cannot make any assessment of the differences between their image and ours, which would help us to understand the problem further.

Excluding NGC 3430, the ratio of the Ashby et al. (2011) measurements to ours is  $0.90 \pm 0.09$ . Ashby et al. assume that their uncertainties are 8%, so the dispersion in the ratio of measurements is reasonably good. The systematic offset may be a consequence of differences between the flux density measurement methods. The second largest mismatch between our measurements and the measurements from Ashby et al. is for NGC 4688, a late-type galaxy with significant diffuse, low surface brightness 24  $\mu\text{m}$  emission; Ashby et al. measure a flux density  $\sim 30\%$  lower than ours for this galaxy. Ashby et al. also noted differences between the flux densities measured for NGC 4395 by themselves and by Dale et al. (2009), which they thought could be the result of incorrectly measuring diffuse emission in NGC 4395 using SExtractor. We suspect that this could also be the reason for the mismatch between the flux density measurements for NGC 4688 and may be the reason for the  $\sim 10\%$  offset in flux density measurements between the reported flux densities from their catalog and ours.

#### 4 SUMMARY

We have gathered together raw MIPS 24, 70, and 160  $\mu\text{m}$  MIPS data for galaxies within the SAG2 and HeViCS surveys and reprocessed the data to produce maps for the analysis of these galaxies. We have also performed aperture photometry upon the galaxies in the surveys that can be used to study the global spectral energy distributions of these sources. The flux density measurements and the images will be distributed to the community through the Herschel Database in Marseille<sup>18</sup> so that the broader astronomical community can benefit from these data.

As tests of our data processing and photometry, we have performed comparisons between our photometric measurements and measurements published by Dale et al. (2007), Engelbracht et al. (2008), and Ashby et al. (2011). Our measurements generally agree

well with the measurements from these other catalogs, and we have documented and attempted to explain any major discrepancies or systematic offsets between their measurements and ours. Given the good correspondence between our measurements and the measurements from these other surveys, we are confident about the reliability of our photometry measurements.

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<sup>18</sup> Located at <http://hedam.oamp.fr/>.

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